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Supplement 21

Diseases of Cereal and Forage Crops

in the United States in 1921

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BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

DISEASES OF CEREAL AND FORAGE CROPS IN THE UNITED STATES IN 1921*

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CONTENTS

General statement

Most of the data which are summarized in this bulletin have been furnished by collaborators of the Plant Disease Survey. Many of the general conclusions also have been contributed in the same way. An attempt has been made to give credit not only for facts but also for ideas. The genesis of an idea cannot always be determined, but it is hoped that due credit always has been given. The compiler has interpreted facts as well as possible and has drawn conclusions which it is to be hoped are accurate. Wherever it has been possible collaborators have been quoted directly. Those referring to material contained in this publication are requested to cite the original contributor if possible.

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* Summaries of diseases of cereal crops in the United States for the years 1918, 1919, and 1920 have been given in U. S. Dept. Agr. Plant Dis. Bul. Supplement 4: 119-159. 1919; 8: 1-81. 1920; 15: 115-176. 1921.

† Temporary appointment while on leave of absence from the Minnesota Agricultural Experiment Station and the Office of Cereal Investigations, United States Department of Agriculture.

Introduction

Cereal and forage crop diseases were not so destructive in 1921 as in some previous years, although the toll which they exacted from these crops was greater than it should be. It is evident from reports of collaborators that gratifying progress is being made in the control of easily preventable diseases such as most of the cereal smuts. Many collaborators call attention to the fact that cereal seed treatment is being practiced quite generally in those areas in which these crops are grown intensively. Better cultural practices no doubt contribute also to minimizing losses from some diseases, especially those which cannot be controlled easily by seed selection or seed treatment. Rapid progress also is being made in controlling diseases by the use of resistant varieties. This is true of such diseases as black stem rust of wheat and oats; the leaf rust of wheat; bunt of wheat; flag smut of wheat; foot rot (so-called take all) of wheat; spot blotch and foot and root rots of barley and, to some extent, of loose smut of wheat.

Collaborators are contributing considerable information on the epidemiology of diseases. Much information is accumulating on the factors which conduce to the development of disease - cultural practices, soil conditions, weather conditions, and crop geography. A fairly accurate study of the relation of the last two factors to the distribution and severity of diseases can be made from the Survey records. In fact, many valuable principles could be deduced if some of the records were more complete. The Office of Plant Disease Survey is undertaking such studies as rapidly as possible but must depend largely on the reports of collaborators for data. The Survey is making an effort not only to record the occurrence of diseases, but also to study their epidemiology.

Weather and diseases in 1921

The weather during the winter of 1920-21 and during the 1921 growing season was such as to favor the rapid development of many diseases early in the season and to inhibit their progress later. The almost unprecedentedly mild winter made it possible for such pathogenes as the rust to develop and spread almost continuously on fall sown grains. The high temperatures and fairly abundant rainfall in the spring also contributed to the rapid development of these diseases. However, the intensely hot, and, in many regions, dry weather in June and July ripened the cereal crops prematurely and checked the development of some diseases, such as the rusts, and probably prevented the development of others, such as wheat scab. Local variations, of course, occurred. While the hot weather checked the development of some diseases, the damage due to drought and heat was increased, thus complicating the estimates of losses. This probably is true of rusts. In many regions the small grain crops ripened so quickly - two weeks earlier than normal in some localities - that no accurate estimate could be made of the damage caused by diseases. In so far as possible the weather relations have been discussed in connection with each disease. It is to be hoped that more complete correlations can be established in the future.

DISEASES OF CEREAL CROPS

WHEAT

Wheat production

The three accompanying maps (Figs. 27, 28, 29), show the geographic distribution of wheat in the United States in 1919. These are based on figures of the 1920 census and are adapted from maps supplied by the Offices of Farm Management and Cereal Investigations of the United States Department of Agriculture.

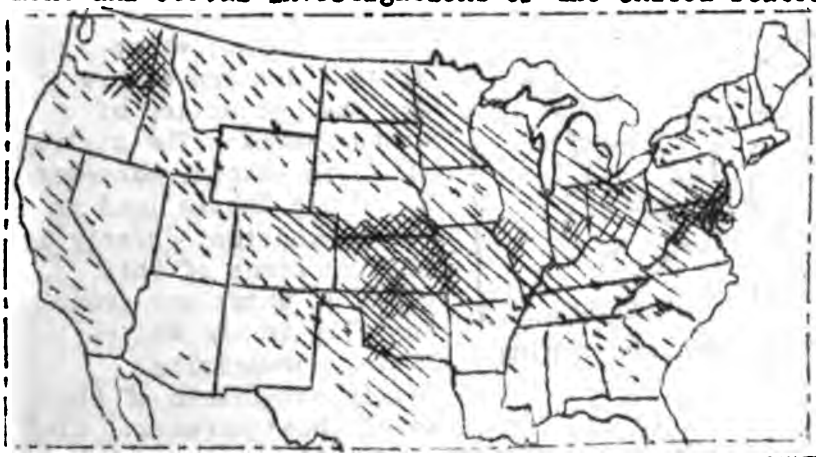

Fig. 27. Distribution of all wheat, 1919.

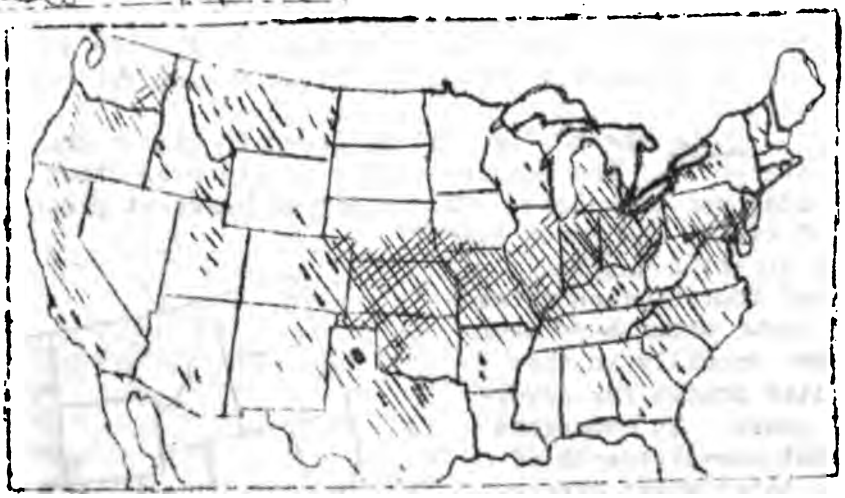

Fig. 28. Distribution of winter wheat, 1919.

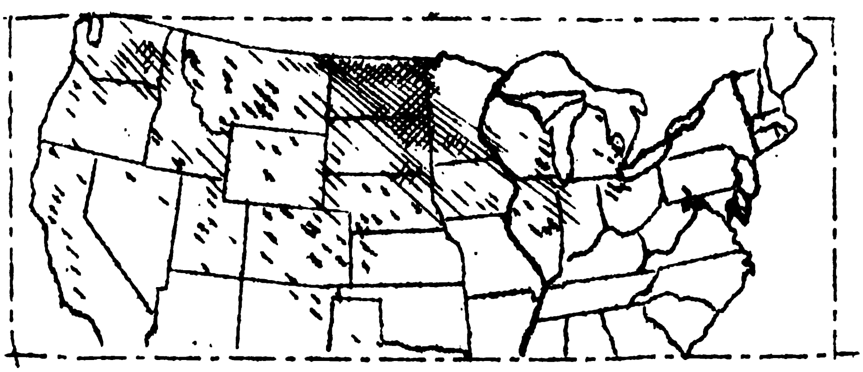

Fig. 29. Distribution of spring wheat, 1919.

Classes of wheat

The following general statements concerning the six commercial classes of wheat have been supplied by the Office of Cereal Investigations, and the text figures are adapted from maps supplied by the same Office.

Under the Official Grain Standards of the United States, wheat is graded in six commercial classes as follows: (1) hard red spring, (2) durum, (3) hard red winter, (4) soft red winter, (5) common white, and (6) white club.

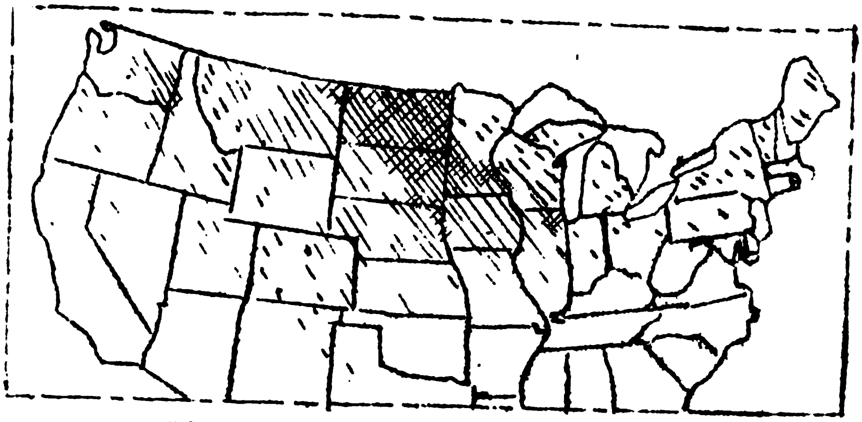

Fig. 30. Distribution of hard red spring wheat in the United States.

Hard red spring wheat (Fig. 30) is grown principally in the north central part of the United States, where winters are too severe for the production of winter wheat. The states of North Dakota, Minnesota, and South Dakota lead in its production. Nearly 14 million acres of this class of wheat are grown annually in the United States, comprising nearly one-fourth of the total wheat acreage. Although there are 24 distinct varieties of hard red spring wheat, about two-thirds of the acreage of this class consists of the one variety, Marquis.

The strongest flours for bread making are produced from hard red spring wheat.

Durum wheat (Fig. 31) is grown in almost the same region as hard red spring wheat. The leading states in its production are North Dakota, South Dakota, and Minnesota. The region of heaviest production of durum wheat is just west of the Red River Valley in North Dakota. About four million acres of durum wheat have been grown annually in the United States for several years. It comprises about one-sixteenth of the total wheat acreage. Arnautka and Kubanka are the leading varieties among the eleven commercial durum wheats grown.

Durum wheat usually yields more than hard red spring wheat in this northern spring wheat region, due to its

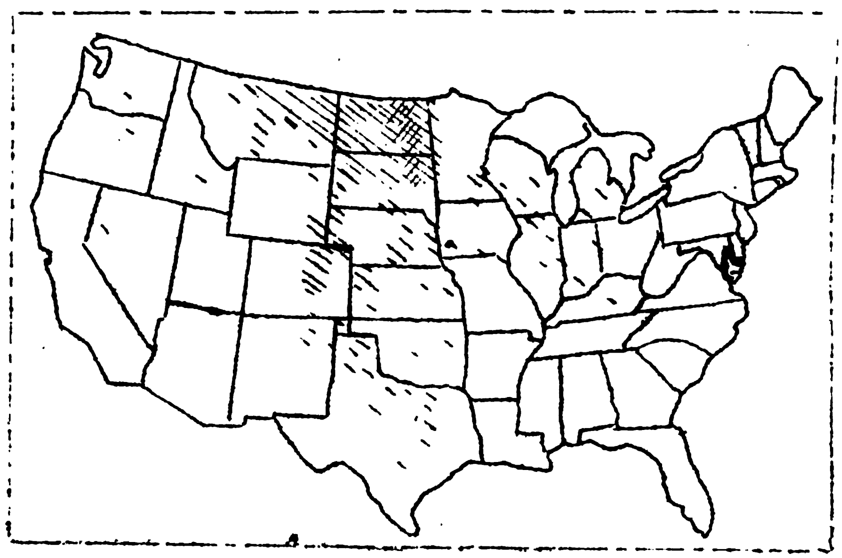

Fig. 31. Distribution of durum wheat in the United States.

greater resistance to drought and to black stem rust. Much of the durum wheat is ground into a granular semolina from which macaroni, spaghetti and other alimentary pastes are made. There is also a considerable foreign demand for this class of wheat.

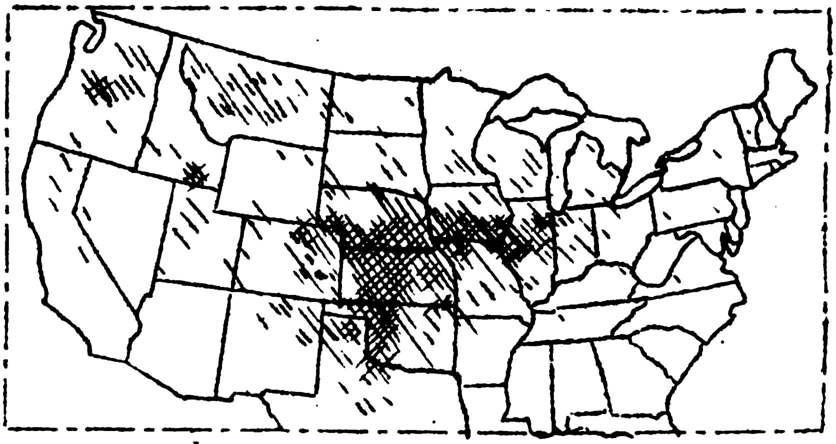

Fig. 32. Distribution of hard red winter wheat in the United States.

Hard red winter wheat (Fig. 32) is grown principally in the Central Great Plains area where dry summers and rather dry winters prevail. The states leading in its production are Kansas, Nebraska, and Oklahoma. Hard red winter wheat is not well adapted to humid sections. More than 17 million acres are grown annually in the United States, comprising less than one-third of the total wheat acreage. The leading varieties are Turkey, Kharkof, and Kanred.

Hard red winter wheat is used in the manufacture of bread-making flour.

Soft red winter wheat (Fig. 33) is largely grown in the humid sections in the eastern half of the United States. The states leading in its production are Missouri, Indiana, Ohio, and Illinois. About 16 million acres of this class of wheat are grown annually, comprising over thirty per cent of the total wheat acreage. About 65 varieties are grown, the principal ones being Fultz, Fulcaster, Mediterranean, Poole, Red May, and Red Wave.

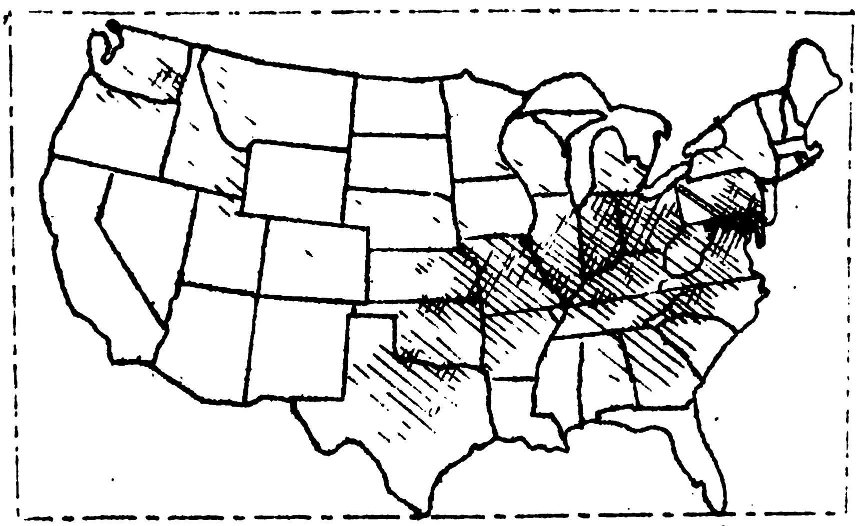

Fig. 33. Distribution of soft red winter wheat in the United States.

Soft red winter wheat is used in the manufacture of both bread-making and pastry flours The flour from this class of wheat often is blended with that of hard red spring and hard red winter wheats for making a stronger bread-making flour.

White club wheat (Fig. 34) is grown only in the western part of this country, principally in the three Pacific Coast states,- Washington, Oregon, and California. In some sections of these states it outyields all other classes. Although more than one million acres of white club wheat are grown annually in the United States, it comprises less than two percent of the total wheat acreage.

White club wheat is used in making starchy flours for pastry or is

shipped to South America and the Orient.

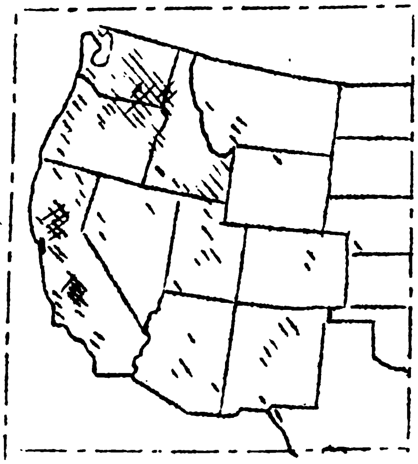

Fig. 34. Distribution of white club wheat in the United States.

Common white wheat (Fig. 35) is grown in both the eastern and western parts of the United States. It is the leading class of wheat in Washington, California, Oregon, and Idaho, and is also important in New York and Michigan. In these states it usually outyields the other classes of wheat. Over three million acres of common white wheat are grown annually in the United States. It comprises somewhat more than five per cent of the total wheat acreage. More than 50 varieties of common white wheat are grown, the leading ones being Pacific Bluestem, Goldcoin, Early Baart, Defiance, Dicklow, and Dawson Golden Chaff.

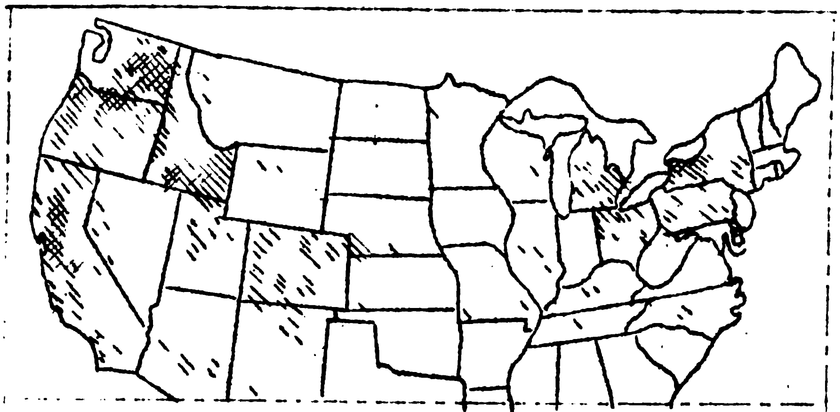

Fig. 35. Distribution of common white wheat in the United States.

Common white wheat is used in making pastry flours and breakfast foods and to some extent in bread-making flours.

Bunt caused by *Tilletia laevis* Kühn and *T. tritici* (Bjerk.) Wint.

Apparently bunt caused less damage in 1921 than in 1920, or in an average year. *Tilletia laevis* seems to be by far the more common of the bunt fungi, except in the Palouse district of the West where *T. tritici* is more abundant. While it is not possible to make very definite statements on the basis of this year's reports, since many pathologists simply reported bunt and did not differentiate between *T. laevis* and *T. tritici*, it is quite evident that east of the Mississippi River most of the bunt is caused by *T. laevis*. The same thing is true in the spring wheat region. In Minnesota and the two Dakotas *T. laevis* certainly is more abundant, and *T. tritici* occurs only rarely. Which form is principally responsible for losses in the hard winter wheat area is not indicated in the reports of collaborators, although it probably is *T. laevis*.

Relative prevalence and importance of bunt in 1921

Bunt was unimportant east of the Mississippi River during the past year. Not a single state collaborator in that section reported more than 1% reduction

in yield on account of the disease. In the New England states no bunt was observed, and the same is true for South Carolina, Mississippi, Louisiana, and Wisconsin. While it is quite probable that the disease occurred, it apparently was so rare as to attract no attention whatever. In the middle western states and in the hard red spring wheat area there was scarcely an appreciable amount of damage. The same is true for the soft red winter wheat area, especially in Ohio, Indiana, Illinois, West Virginia, Kentucky, and Tennessee. However, it was more prevalent and destructive than in 1920 in the hard red winter wheat region of Nebraska, Kansas, Oklahoma, Colorado, and northern Texas. Learn reports that the percentage of bunted heads in fields in southeastern Colorado ranged from 5 to 55%, and Melchers states that in Kansas there was as much as 75% of bunt in some fields. The disease also was quite prevalent in the state of Coahuila, Mexico. It was present in practically all of the fields visited near Saltillo and in some fields the yield was reduced by at least 25%. It was reported that there was less bunt than usual in Montana, although the estimated reduction in yield for the state was 4%. In Idaho, Hungerford also reported that the yield was reduced by about 4% on account of bunt. It is said to be more severe in northern Idaho than in the southern part of the state. In Washington, according to Heald and others, as many as 50% of the heads in some of the fields were destroyed by the disease. There was said to be about the same amount as usual in Oregon, where the most found in any one field was 40%. Mackie states that bunt was quite general in California, but that there was less than in previous years. The reduction in yield in California was about 2%. As is well known, in the drier regions of these western states soil infection may occur.

The following reports summarize the situation and indicate the prevalence of bunt in the different parts of the country:

New York: The amount of covered smut, or bunt, caused by *Tilletia foetens* found in winter wheat seems to be negligible. One or two heads were all that could be found in any fields with the exception of two cases. In these two cases, which occurred in Niagara and Montgomery Counties, there was one and three percent of smut, respectively. In the spring wheat no covered smut was found. (R. S. Kirby).

Ohio: This trouble has been conspicuous by its absence this year and few fields were found with more than a trace of stinking smut. (Clayton).

Indiana: Local; not as much as in previous years. (Jackson).

West Virginia: Bunt was exceedingly slight. (Anthony Berg).

Kentucky: According to reports from millers, there is practically no bunt in Kentucky wheat this year. (Valleau).

Tennessee: (Observations made during April, May, and June in the vicinity of Knoxville, Murfreesboro, Columbia, Nashville, Jackson, and Union City.) Bunt smut was actually observed only in a few fields, and then in very small amounts. The damage should be considered very slight to none. Many growers treat the seed for the smut. (Sherbakoff).

Nebraska: Slight general infection throughout the state. Heavier than last year. One county reports 20% infection. (Goss).

Kansas: Bunt was very prevalent this year causing a great deal of damage. (Melchers and Stokdyk).

Stinking smut or bunt is quite generally distributed over the state again this year and is serious in some of the Kanred fields sown with smutty, untreated seed. (John H. Parker).

Oklahoma: (Perry, Newkirk, Medford, Enid, Cherokee, Alva, Fairview, Watonga, El Reno, Kingfisher, Norman, Oklahoma City, and Guthrie.) Covered smut of wheat, while not found in many fields, has been serious where found. For instance, one field near Fairview showed a loss of 10%, while one near Watonga showed a loss of 30%. (Stratton).

Colorado: In one county in the southeast corner of the state it was very general; reports were received stating a loss of from 5-55%. Farmers were very much concerned and desired to know of some means of control. It has been reported from several other localities in the state and a field was visited by the writer where there was a damage of 25%. The smut condition in the southeast corner of the state is the worst ever brought to my attention. (Learn).

Texas: Reports were received from parties at Benton, Texas that as high as 50% was present in some fields. There were fears of smut explosions in threshing machines and the question of using fans on the separators was considered but not put into practice. (W. H. Tisdale).

Washington: (Yakima Valley) Bunt of wheat is more prevalent this year than usual. (George L. Zundel).

Very little in spring seedings but some heavy infections in winter wheat. Fields showing 50% or over have been observed. (Heald).

Table 20. Highest percentages of bunt in individual fields, as reported by collaborators of the Plant Disease Survey, 1921.

State	Highest percentage	State	Highest percentage	State	Highest percentage
Kansas	75	Oregon	40	Delaware	6
California	65	Pennsylvania	30	Michigan	5
Washington	50	Nebraska	20	South Dakota	5
Texas	50	Maryland	8	New York	3

The following table (Table 21) shows the amounts of bunt during 1921 as compared with 1920:

Table 21. Relative amount of bunt in 1921 as compared with that in 1920.

Less than in 1920	More than in 1920	About same as in 1920
West Virginia	Nebraska	New York
Kentucky	Kansas	Virginia
Tennessee	Idaho	Maryland
Indiana	Oklahoma	North Carolina
Michigan	Colorado	Georgia
Minnesota	Texas (probably)	Arkansas
South Dakota	Delaware "	Illinois
Montana		Oregon
California		

There was about an average amount in North Carolina, Georgia, Arkansas, Illinois, Idaho, and Oregon, while Coons reports that there was less in Michigan than there is in the average year.

The map (Fig. 36) shows the prevalence and gives estimated losses caused by bunt in 1921.

Factors influencing the amount of bunt

1. Weather conditions

There are two possible reasons for the unusually small amount of bunt. It is quite probable that unfavorable weather conditions reduced the amount of the disease. Mackie calls attention to the fact that winter wheat did not become infected in California on account of an early, dry fall in 1920, and Essary, Hesler, and Sherbakoff mention also the effect of the dry fall of 1920 in Tennessee. The fairly dry spring probably accounts also for the relatively small amount of bunt in some of the hard red spring wheat states and in some of the soft red winter wheat states. Several other collaborators comment on the unfavorableness of the weather for the development of the disease. However, some of them point out that warm, dry weather prevented infection, while others suggest that cool, wet weather prevented infection. It would be desirable to make observations on the exact relationship between weather conditions and the development of the disease. In the hard red winter wheat area, in which the disease was more prevalent than it was in 1920, it is probable that high precipitation shortly after the wheat was sown may have been responsible for the heavy infection. Melchers mentions the probable effect of heavy precipitation in Kansas.

2. Use of seed treatment

In some states seed wheat apparently is more generally treated now than previously. Mackie points out that much of the seed wheat is treated in California and that this fact probably accounts for the reduction in the amount of bunt. Jennison states that this is true in Montana also, and Essary, Hesler, and Sherbakoff report that treatment is quite general in Tennessee. It is quite probable that the general use of methods of seed disinfection has been responsible for the reduction in the amount of the disease, since the Extension Divisions in several states have made campaigns during the past few years for

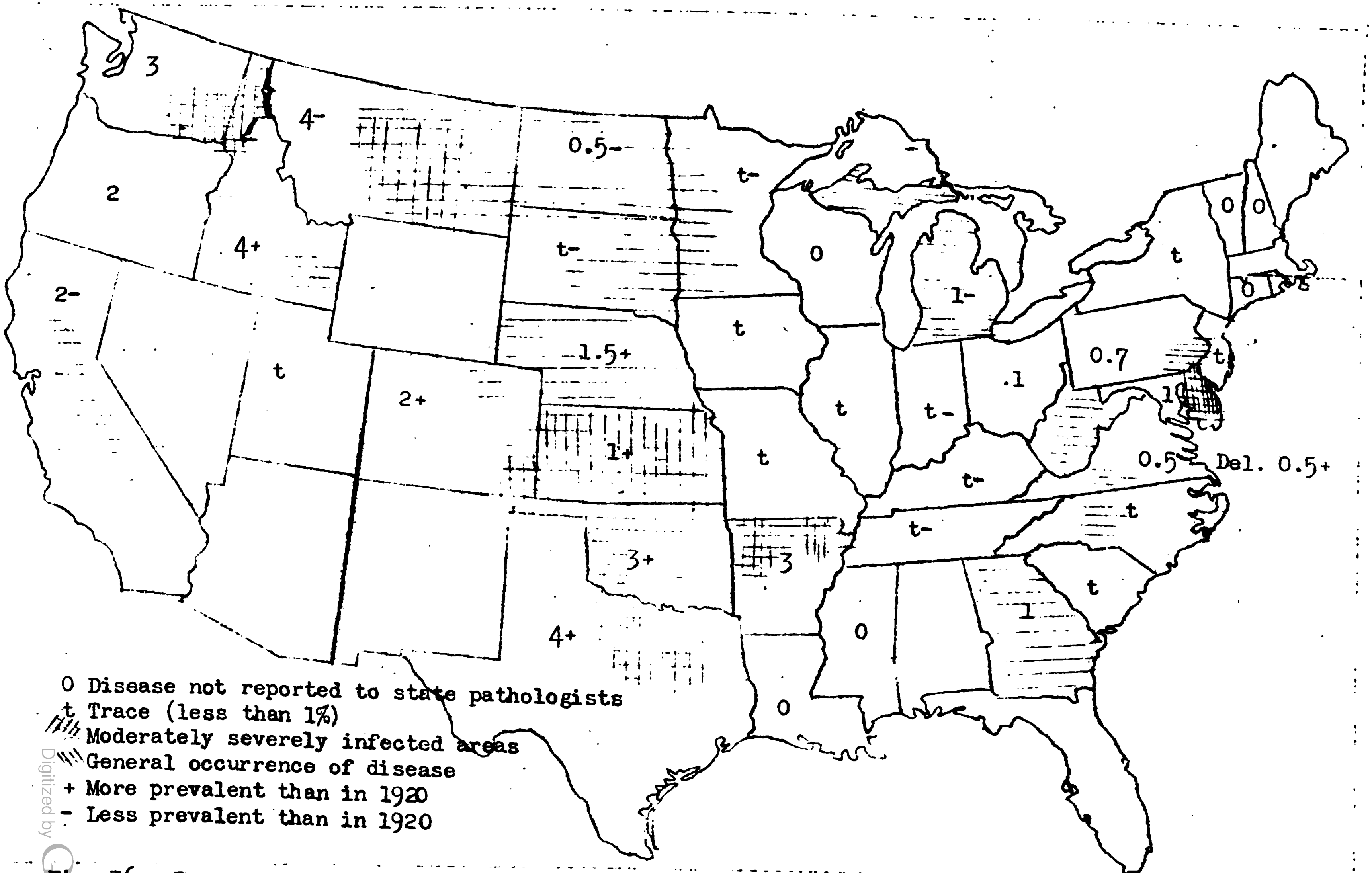

Fig. 36. Percentage reduction in yield from bunt of wheat in 1921, as reported to the Plant Disease Survey.

seed treatment. If this is true, it is highly gratifying. It would be extremely interesting to find out to just what extent the application of control measures has contributed to the desired result.

Control of bunt

Progress has been made in perfecting further the methods of seed treatment. Heald and Zundel have shown that seed injury caused by formaldehyde can be minimized by dipping the treated seed in lime water, made by adding one pound of lime to ten gallons of water (1, pp. 18-19).

The value of treating badly smutted wheat seed is shown strikingly by the following summary of results obtained by the Office of Cereal Investigations in experiments conducted at Arlington Farm, Virginia:

"The seed treatment experiment in which Seed Protecto and Formaldehyde were used on Purple Straw, C. I. 1915, inoculated with T. laevis spores by Dr. G. M. Reed was thrashed June 14. Yields on the six plats of 1/40 acre each in the test are uniform, as may be seen from the figures:

	Bu. per acre	Av. bu. per acre
Check		
Plat No. 1	4.6	
Plat No. 4	5.0	4.8
Formaldehyde treated		
Plat No. 3	15.8	
Plat No. 6	17.1	16.4
Seed Protecto treated		
Plat No. 2	13.8	
Plat No. 5	16.3	15.0

"Stinking smut balls composed at least 50% of what was obtained from the check plats." (J. W. Taylor, Cereal Courier 13: 134. July 20, 1921.)

Further experiments have been made on the use of chemical dusts for the control of bunt; and the indications are that the treatment of seed with copper carbonate dust or with dehydrated copper sulfate and lime will soon be used generally. The advantages of this treatment are quite obvious. Excellent results have been obtained in the Antipodes, and also in California, Washington, and Minnesota. It is quite probable that experiments have been made in other states also, but information is not yet available. The following statements summarize the situation.

Washington: Treatment with copper carbonate dust, two ounces per bushel recommended by Heald and Zundel (1, p. 18).

The following seed treatments were tested on two varieties of spring wheat that had been heavily smutted: Hypoform, chlorophol, copper carbonate dust, anhydrous copper sulphate dust, bluestone 1-1 sprinkle, sulphur and formaldehyde. Perfect control was secured by the following:

1. Hypoform	1 lb. to 5 gal. water	30 minutes
2. Chlorophol	1 part to 300 water	60 "
3. Copper carbonate dust	2 ozs. per bushel	
4. Anhydrous copper sulphate 1 part, Calcium carbonate 1 part	2 ozs. per bushel	
5 Sulphur	20 lbs. per bushel	

Seed treated with formaldehyde 1 lb. to 40 gallons water and the bluestone 1-1 sprinkle gave traces of smut. There was practically no reduction in germination in the case of hypoform, chlorophol, copper carbonate dust and anhydrous copper sulphate treatments.

Field tests secured by the Extension Plant Pathologist point to the probable value of the copper carbonate dust treatment in reducing the smut from soil contamination. Present information will justify the conclusion that the copper dust treatments are as effective as either formaldehyde or the bluestone steeps, more convenient to use and less injurious to the seed. (Heald).

California: Bunt was found in spots where the seed wheat had not been treated, one field being found with 65%, but, as a rule, the attack is reduced from that of last year. Seed treatment is more generally practiced. The average loss for the state may be given as 1.5%. (Mackie).

Recent notes taken in the smut plots at Fresno indicate that copper carbonate and copper sulphate-lime dusts do not injure the seed in any way, but on the contrary, produce better stands and more advanced growth than non-treated seed. Laboratory examinations of bunted wheat sown in the soil between filter papers showed no germination of bunt spores where the seed was treated with the copper dusts but profuse germination of non-treated bunt spores. (W. W. Mackie, Cereal Courier 13: 38. Mar. 15, 1921).

The tests with chemical dusts for bunt control gave very encouraging results. Copper carbonate dust was slightly more effective in controlling bunt than the standard bluestone and formaldehyde treatments. Copper carbonate dust did not cause any appreciable seed injury, while both bluestone and formaldehyde caused considerable injury. (F. N. Briggs, Cereal Courier 13: 203. Sept. 10, 1921.)

Minnesota: The following tabular summary (Table 22) of results with copper carbonate dust is taken from an abstract by E. B. Lambert and D. L. Bailey (2). The experiments were made on spring wheat and oats at University Farm, St. Paul, Minnesota. It was found that copper carbonate used at the rate of two ounces per bushel, not only eliminated smut, but also increased the yield.

Table 22. Results of experiments conducted during 1921 at University Farm, St. Paul, Minnesota on the use of copper carbonate dust in preventing bunt of wheat and smut of oats.

Treatment	Wheat: Per cent decrease in germination	Wheat: Per cent* bunt	Oats: Per cent decrease in germination	Oats: Per cent smut
Check		18.5		13
Concentrated Formaldehyde (50-50)	33-62	2.1	0	3.0
Standard sprinkle (1-320)	21-42	1.4	0	0.2
Copper-carbonate dust (2-4 oz.)	See text	0	0	0

*Average of several tests.

Resistance of varieties

Work still is in progress in various places on the development of varieties resistant to bunt. The following summary gives briefly the results:

Minnesota: This year 250 varieties were tested and of these several were almost immune to bunt, while a number are very highly resistant. Some, including some hard red spring wheats and some durums, are moderately resistant. (Stakman, Lambert and Bailey).

Oregon: Turkey Red rather highly resistant. White Club Hybrid types very susceptible. (Barss).

The following excerpts from the Cereal Courier summarize the results obtained by the Office of Cereal Investigations in Virginia and in California:

Virginia: The past season was a very favorable one for the development of bunt in this locality. Percentages in most of the varieties were high this year as compared with almost no infection last year. About 250 varieties and strains were tested to determine their behavior toward infection by both T. laevis and T. tritici, the two strains of the bunt fungus. Of these wheats, one strain each of Gladden and Red Hussar were free from T. laevis. Other strains showed from 5 to 70% or more of infection. Kanred showed a high degree of resistance to T. tritici but none of the varieties or strains was entirely free from infection. Very few varieties showed any marked degree of resistance.

The percentages of both species of Tilletia were lower in almost every case in 23 varieties of wheat sown October 12 than they were in the same varieties sown October 30. In this set of experiments the percentages of T. laevis were generally higher than those of T. tritici for the same varieties. None of these varieties was free from smut in either plat. (W. H. Tisdale. Progress report on cereal smut investigations at Arlington Farm, Virginia, 1921. Cereal Courier 13: 280-284. Nov. 30, 1921.)

California: Although it had not been noted previously, it appears that Hard Federation is quite susceptible to bunt. Bunt was observed most frequently on this variety and at Paso Robles a heavy infection was found in one of the two sowings. At this point frost had injured badly a portion of the plat with the remainder about normal. On the frosted portion a bunt infection of 25% was recorded, while on the unfrosted portion there was a 2% infection.

On the White Federation plat only a trace of bunt was found on both the frosted and unfrosted portions. (V. H. Florell (Chico). Cereal Courier 13: 106-107. June 10, 1921.)

Recent literature

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(2) Lambert, E. B., and D. S. Bailey. Results of treating seed of spring wheat and oats with copper carbonate dust to prevent smut. (Abstract.) Phytopath. 12: 36-37. Jan. 1922.

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Loose smut caused by <u>Ustilago tritici</u> (Pers.) Jens.

Loose smut, as usual, was very generally distributed and some was present in practically all regions where wheat is grown. While most of the collaborators reported that the disease was general apparently it was not so destructive as in 1920. It was reported to be less prevalent than in the previous year in eight states, while in four it apparently was slightly more injurious than last season. The disease apparently did the greatest damage in Pennsylvania, Maryland, Virginia, West Virginia, Kentucky, Indiana, Illinois, Michigan, and Arkansas. The greatest reduction in yield probably took place in Michigan and Kentucky where Coons and Valleau estimated 5% and 4% respectively. Apparently loose smut does the greatest damage in the soft red winter wheat area. In the hard red winter wheat section of northern Texas, Oklahoma, Kansas, and Nebraska, the disease seems to be of little importance. In the hard red spring wheat region the disease also is of minor importance, except locally. In certain localities, for instance, in Minnesota in the west central part of the state, as many as 25% of the heads were infected. Many state collaborators report that the disease is insignificant and practically all of them state that it is not enough to justify any campaign for the use of modified hot water treatment. In some states, however, the disease seems to be increasing in severity, as is shown by the following comments:

<u>New York</u>: Loose smut presents a difficult problem to the New York farmer. The loss averaged by counties in New York was 1.8%. However, this 1.8% loss may be a rather high field average, since most of the larger wheat-producing counties had from a trace to less than 1% of loss. This seemingly comes about by two factors as follows: First, No. 6 Junior is the principal wheat of the main producing area and this variety seems to be resistant to loose smut. This fact was pointed out to the writer by Mr. F. R. Perry of the Hickox-Rumsey Company, and the writer's subsequent observations corroborated this. There was seldom over a trace of loose smut in No. 6 Junior wheat, while in Dawson's Golden Chaff and Red Rock, the percentage of loose smut averaged between 3 and 4 per cent. The two highest percentages of smut found in any one field of several varieties follows:

Red Rock	19%, Wayne County;	12%, Monroe County
Dawson Golden Chaff	26%, Oswego County;	19%, Niagara County.

The second factor is that the farmers in the main winter wheat producing area obtained their seed from cleaner fields. Very little hot water seed treatment was used by farmers questioned by the writer.

Loose smut seems to be a smaller factor in spring wheat than in winter wheat. In the true spring wheat region of New York state which lies just south of the St. Lawrence River, only about 10% of the spring wheat fields have over 1% of smut and most of the acreage had only a trace. (R. S. Kirby).

Indiana: Loose smut is more abundant, generally speaking, than usual when the whole state is taken into consideration. In this connection it has been interesting to note that wheat treated with hot water in 1919, while it gave a clean crop in 1920, is showing an abundance of smut this year, indicating that under favorable conditions for infection smut may increase very rapidly in treated wheat. It is practically impossible to get seed plots isolated and I am now inclined to think that smut may carry for some distance, especially in bright weather when there is a good breeze. I see no reason why this should not be true, though I do not believe we have very much data on how the loose smut will spread. (Jackson).

Idaho: Losses from loose smut of wheat have been increasing each year in the irrigated sections of southern Idaho. This year the amount of infection in various sections surveyed varied from one-half to 8%. Dicklow wheat, which is considered the best spring wheat for southern Idaho, appears to be very susceptible to loose smut. In connection with certification work conducted by the University Extension Division a considerable amount of hot water seed treatment has been carried on. In some instances individual farmers have treated their own seed but in most cases a member of the Extension Division has aided in the work. Uniformly good results have been secured. Loose smut has been controlled and no serious case of injury has been reported.

A rather extensive campaign for this type of treatment for the control of loose smut of wheat is being planned for this year. We are recommending treating only a small amount of seed for a seed plot. (Hungerford).

The highest percentages of infected plants in individual fields were as follows:

New York	- 26%	Kentucky	- 7%
Minnesota	- 25%	Maryland	- 8%
Michigan	- 20%	Virginia	- 8%
Pennsylvania	- 18%	Oklahoma	- 5%
Indiana	- 15%	South Dakota	- 3%
Mississippi	- 12%	Montana	- 3%
West Virginia	- 10%	Oregon	- .5%
Missouri	- 9%		

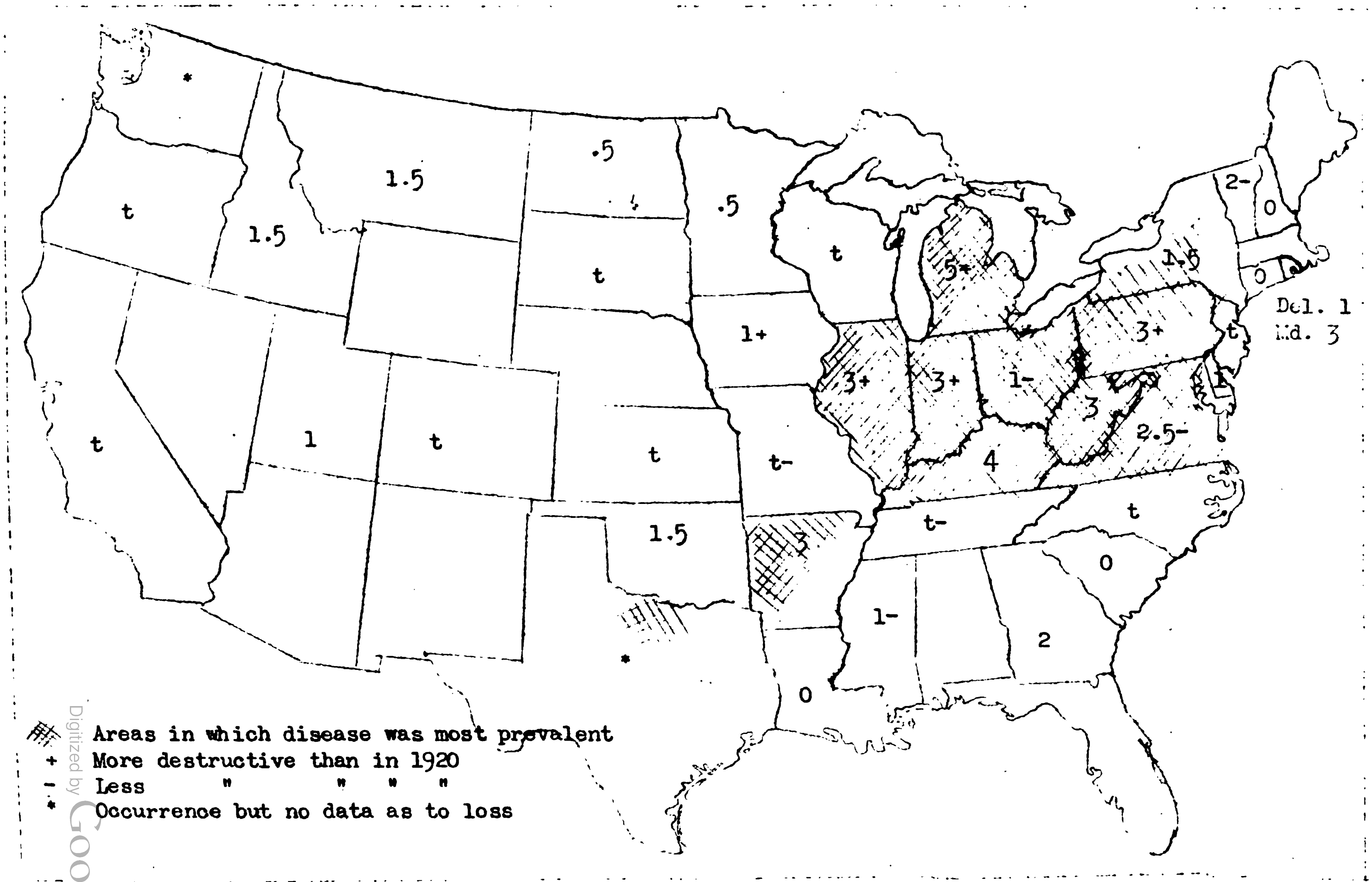


Fig. 37. Percentage reduction in yield from loose smut of wheat in 1921 as reported to the Plant Disease Survey.

The map (Fig. 37) and the following table (Table 23) give the estimated losses from loose smut in 1921.

Table 23. Losses from loose smut of wheat in 1921.

Approximate Percentage loss	States
5%	Michigan
4%	Kentucky
3%	Pennsylvania, West Virginia, Maryland, Arkansas, Indiana, Illinois
2.5%	Virginia
2%	Vermont, Georgia
1.5%	New York, Oklahoma, Montana, Idaho
1%	Delaware, Mississippi, Iowa, Utah, Ohio
Less than 1%	North Carolina, Missouri, Wisconsin, Minnesota, North Dakota, South Dakota, Kansas, Colorado, Washington, Oregon, California. (In all these less smut than in 1920.)

Several collaborators suggest that unfavorable weather conditions at flowering time of the wheat in 1920 were responsible for the rather small amount of smut during the past season. Sherbakoff suggests that wet weather at flowering time possibly may explain the small percentage of smut in Tennessee, while Barss and Mackie suggest that in Oregon and California, respectively, the dry air probably prevents abundant infection.

Susceptibility of varieties to loose smut

There are sharp differences in varietal susceptibility. Stratton states that in Oklahoma Kanred and Black Hull Turkey are the least susceptible, while Thomas reports that in Ohio smut is particularly prevalent in Goens. Coons states that in Michigan loose smut is the most common cause for the rejection of inspected fields of Red Rock. Bolley observes that in North Dakota both the durum and bread wheat varieties are susceptible. Fromme states that the occurrence of the disease in Virginia is determined chiefly by the range of wheat varieties and that it is an important factor in all sections in which Stoner is the predominant variety.

Very probably one reason why loose smut seems to be particularly destructive in the soft red winter wheat region is the susceptibility of many of the varieties commonly grown in that region.

The following table (Table 24) summarizes comments made on varietal susceptibility this year. In the Plant Disease Bulletin Supplement 15, pages 121-124 is given a complete summary of data which had been accumulated in cereal disease surveys up to the time of the publication of that Supplement.

Control of loose smut

The modified hot water treatment for the control of loose smut is not used extensively. Most collaborators report that the disease is not destructive enough

Table 24. Varietal susceptibility of wheats to loose smut.

Susceptible		Resistant	
Variety	Authority[2]	Variety	Authority
Fultz[1]	Tisdale[3]	Fulcaster[1]	Tisdale
Mediterranean	"	Harvest King	"
Currell	"	Mammoth Red	"
Dawson	"	No. 6 Junior	Kirby
Golden Chaff	" ; Kirby	Leap's Prolific	Fromme
Goens	" ; Thomas	Fultz[1]	"
Red Rock	Kirby	Trumbull	Clayton
Stoner	Fromme	Kanred	Stratton
Red Wonder	Fromme	Black Hull Turkey	"
Fulcaster[1]	"		
Red Wave	Clayton		
Portage	"		
Dicklow	Hungerford		

1 = Reported both as susceptible and as resistant - probably due to different varietal strains, according to Tisdale.
2 = Data furnished in reports to Plant Disease Survey unless otherwise specified.
3 = W. H. Tisdale, in Cereal Courier 13: 280-284. 1921.

to warrant a campaign for seed treatment, and the cumbersomeness of the treatment probably also acts as a deterrent. A special questionnaire on this subject was sent to collaborators and replies were received from most of them. Apparently the hot water treatment is used but little in the following states: Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Kentucky, Tennessee, South Carolina, Georgia, Mississippi, Louisiana, Oklahoma, Arkansas, Wisconsin, North Dakota, Iowa, Nebraska, Kansas, Montana, Arizona, Washington, Oregon, and California.

The following comments are made by collaborators in those states in which some organized work has been undertaken:

<u>Pennsylvania</u>: We have conducted demonstrations for control of loose smut of wheat by the hot water method for two years with most satisfactory results. This year demonstrations were conducted in Jefferson, Armstrong, Lebanon, and Juniata Counties. In Armstrong County 500 bushels of wheat were treated. If conditions are favorable about 90 bushels can be treated a day by the barrel method. Perfect control of smut was secured this year from treatments in the fall of 1920. Unfortunately, no yields were secured but Mr. P. R. Smith, the demonstrator, tells me that the stands were perfect and evidently the increase in the yield on the treated fields was much greater than the per cent of smut present in the untreated fields.

We can say with considerable confidence that the method is not used by farmers in this state to any extent except in relation to our extension demonstrations. (Orton).

<u>Maryland</u>: We use the modified hot water treatment simply as demonstrations. So far we have had very good results.......... We usually

treat not more than ten bushels for demonstration. (Temple).

Virginia: During the past season one of these plants was established in Nelson County and 300 bushels of wheat were treated. Demonstrations of the hot water treatment were given in Amherst County and 60 bushels in all were treated. (Fromme).

West Virginia: The treatment has been used to some extent in the eastern part of the state but only in small areas and under the supervision not only of the county agent but of Mr. Berg and Mr. Sherwood. The treatment was given under rather difficult conditions since there was no central point where a large quantity of water could be easily held at a constant temperature but the results were very good. Germination was apparently not affected in at least 50% of the cases. In other cases the grain was injured somewhat. We made germination tests beforehand and suggested using increased quantities of seed which took care of any weak grain. (Giddings).

Ohio: This control method is used in Ohio very little. About 150 bushels were treated last fall in six different counties in demonstration work made by the Extension representatives in cooperation with the county agents. All of the wheat at the Ohio Agricultural Farm at Wooster, except the checks, was treated. I know of no instance where individual farmers are attempting any control of loose smut of wheat. (Roy Thomas).

Indiana: The first use of hot water treatment in this state was in 1917 when six demonstrations were put on, using the sack and basket method. During 1918 a number of individual demonstrations were conducted in various parts of the state which also attracted considerable attention. These, together with the successful results of Mr. East, resulted in eight central treating plants being established in the fall of 1918. This was increased to 20 in the fall of 1920 and was further increased last fall. In the meantime the sack and barrel method is still used for preliminary demonstrations in counties where the interest has not yet been worked up to a point of establishing a central treating plant. In this connection it is interesting that all of the 20 treating plants which were used in 1920 were again used in 1921. Some variation of the method originally used by Mr. East has been made in other counties. For example, a portable treating plant has been used in Posey and Knox Counties. This is essentially the same sort of apparatus that Mr. East has been using, but so arranged that it can be taken by truck from township to township, the steam usually being supplied by a traction engine.

In general, I may say that the method has been a decided success and I think that there will be still more central treating plants used in the fall of 1922. Naturally a number of problems needing investigation have arisen in connection with this work. In the summer of 1921, for instance, it was noted that seed treated in the fall of 1919 showed a rather high percentage, in some cases as much as untreated seed. This occurred under conditions where it seemed evident that the smut must have carried considerable distance during the growing season of 1920.

We feel that the method should be used only in connection with the seed plot system except perhaps under certain unusual conditions. (Jackson). (See F. J. Pipal. Hot water treatment for seed wheat. Purdue Univ. Dept. Agr. Ext. Bul. 100: 1-16. Fig. 1-5.)

Missouri: Although a few men treated last year, yet the practice is not at all widespread. It is hoped that more farmers will treat their seed this year. I have had one or two letters from growers asking for information about the method of preventing loose smut. (Hopkins).

Illinois: A few years ago, a number of the progressive farm advisers of the state thought it would be advisable to assist their farmers in the treating of wheat for loose smut. However, after they had learned the expense of the necessary equipment for this work and saw the need for very careful work throughout the operation, they changed their minds. Loose smut in Illinois is probably not destructive enough to merit the installation of treating plants. If the hot water method is used very much in this state it is in a very limited way and probably only by investigators. (Dungan).

Minnesota: Demonstrations carried on in several places in Otter Tail County. Results were excellent. Smut was practically eliminated from treated lots and in some of the checks there was as much as 20% of smut. (R. C. Rose).

Idaho: Extensive campaign being planned. (Hungerford)

It is quite probable that seed treatment would be used more generally if the method were simpler. Several years ago experiments were made by the Office of Cereal Investigations and the Minnesota and Wisconsin Experiment Stations on the effect of pasteurization. The results were very promising and indicated that the smut could be eliminated from seed lots by soaking from two to three hours in water at a temperature of from 45° to 48° C. Tisdale's summary in the Cereal Courier indicates that excellent results have been obtained recently by similar methods.

"Further use of the simplified hot water treatment has given gratifying results. It has a number of advantages over the method which has been in common use. In brief, it (1) reduces the period of treatment about one-half; (2) eliminates three of the four immersions and the labor incident thereto; (3) completely controls loose and covered smuts as shown by two years' results (4) increases the yield, whereas the old method decreases it (one year's results), and (5) reduces the cost of treatment about one-half.

"The steam treatment methods have also given promising results. The object has been to devise methods for treating large quantities of grain with steam and drying with commercial grain dryers. Small models of several standard makes of machines have been used. It has been found possible to maintain a saturated atmosphere at a very constant temperature by employing very simple devices and alterations on the

machines. Complete control of both loose and covered smut has been obtained without seed injury. The cost of treatment on a commercial scale will be reduced if the method continues to prove successful.

"Varietal tests were not undertaken on a large scale this year, but those which were conducted show that some of the popular varieties, such as Fultz, Mediterranean, Currell, Dawson, Golden Chaff, and Goens, are very susceptible, while Fulcaster, Harvest King, and Mammoth Red showed a marked degree of resistance.

"Physiological studies on the parasitism of U. tritici were recently initiated. There is considerable evidence to show that infested plants do not suffer a lessened capacity to resist winterkilling." (W. H. Tisdale. Progress report on cereal smut investigations, Arlington Farm, Virginia. Cereal Courier 13: 280-283. 1921.)

Flag smut caused by Urocystis tritici Koern.

Flag smut was discovered in the United States for the first time in 1919. As a result of the survey made in that year the disease was found in 33 fields on 20 different farms in Madison County, Illinois. The total infested acreage was approximately 825. In 1920 the disease was found in 111 fields covering an area of approximately 2500 acres. The total infested area was about 47 square miles but the disease was not known to occur outside of Madison County.

Flag smut survey in 1921.

In 1921 the Plant Disease Survey, in cooperation with the Office of Cereal Investigations of the Bureau of Plant Industry of the United States Department of Agriculture, and with the Illinois State Department of Agriculture, made an intensive flag smut survey in the portion of Illinois bordering on Madison County and in the Mississippi Valley in Tennessee and Missouri. An attempt was made to ascertain whether the disease occurred in other regions also. Special surveys were made by collaborators in many of the wheat-growing states and many posters as well as other publicity material were distributed. Flag smut was found only in Illinois, but an infested area was located in St. Clair County just south of Madison County where the smut had not been seen previously. (Fig. 38).

The infested area in Madison County (Fig. 39) is near Granite City and is about thirteen miles long, and between six and seven miles wide. In 1921 the area was extended somewhat and the quarantined zone was increased from forty-seven square miles to sixty-one. In 1921 the disease was found in 120 farms out of 200 inspected, and was found in 211 fields, 100 more than in 1920. This may not be due entirely to an actual spread of the smut, but partly to the fact that the survey was carried on more intensively in 1921 than in 1920. The men got into the field earlier and had a better opportunity of locating the disease.

The infested area in St. Clair County is about 3 x 3-1/2 miles in extent and there are 57 infested fields on 30 different farms. There are 3 fairly distinct areas of infestation: One, by far the largest, is near the town of Dupo, another near Cahokia, and still another near East St. Louis. About one-third of the infested fields are in bottom lands of the Mississippi River and

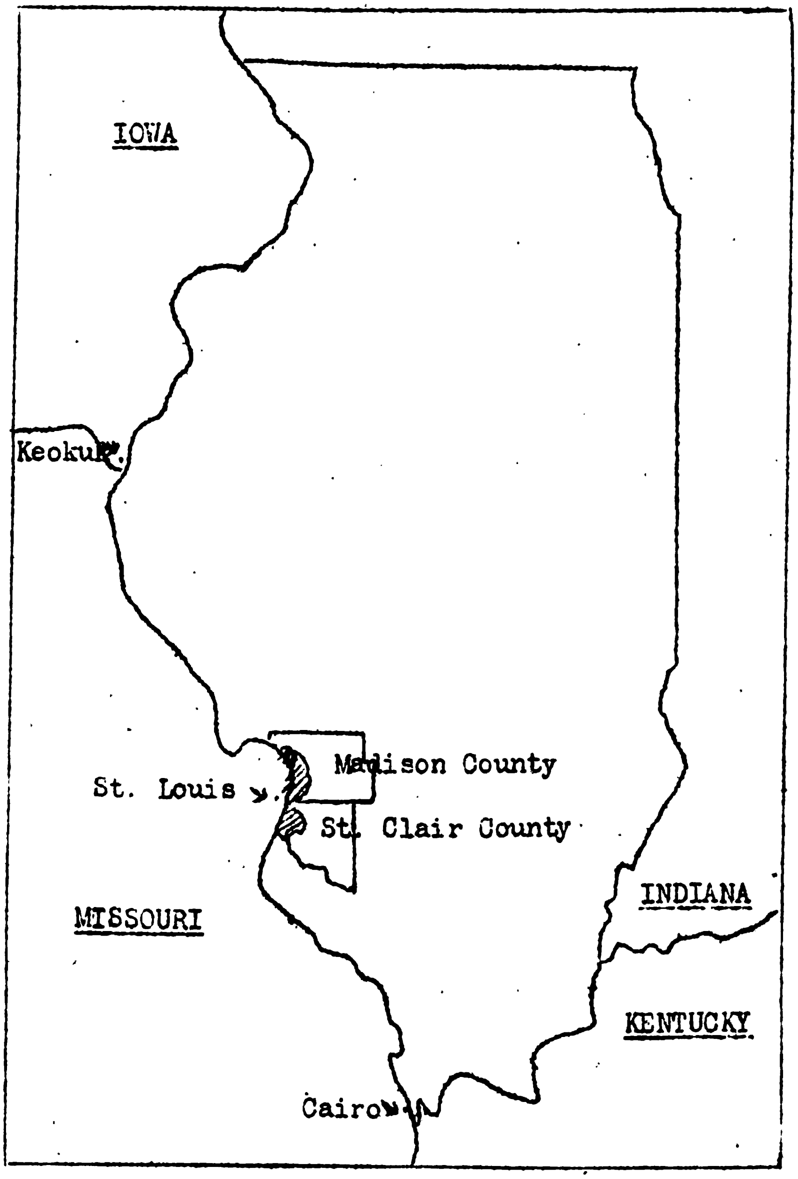
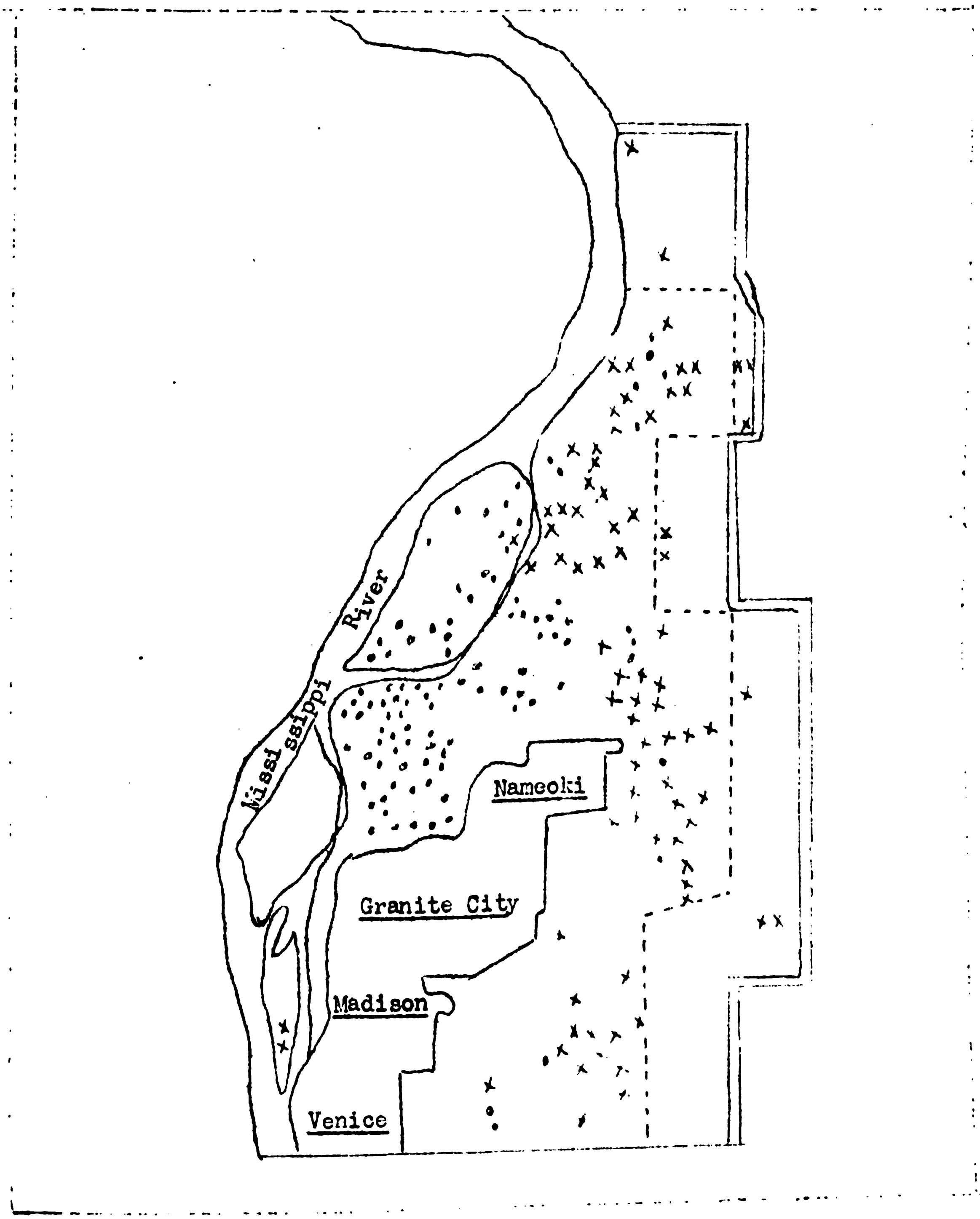


Fig. 38. Location of areas in Illinois quarantined on account of flag smut. Shaded portions represent infested areas.



= Quarantined line for 1921
= " " " 1920
= Dots represent infested fields in 1920
= Infested fields first observed in 1921

Fig. 39. Flag smut area in Madison County, Ill., in 1920 and 1921 showing the increase in size of the infested area.

the others are on high, uneven land.

The following summary of the work done and the results obtained in Dupo section proper, is taken from a special report prepared by R. J. Haskell:

Size of territory covered - - - - - - - - - - - -	About 45 sq. mi.
Total area of farms visited (acres) - - - - -	4817-1/2 A.
Number fields inspected - - - - - - - - - - - -	122
Number farms with flag smut - - - - - - - - - -	28
Acreage of farms with flag smut - - - - - - - -	2916 A.
Number fields with flag smut - - - - - - - - -	50

Prevalence and importance of flag smut

While the known region of infestation apparently is increasing, the disease does not seem to be becoming more destructive within the infested area. Although flag smut can do considerable damage, as is indicated by the fact that in one field 15% of the plants were infected, apparently it is being held in check, or even being reduced on individual farms. This is due very largely to the fairly general practice of treating the seed and of rotating crops. The situation with respect to the destructiveness of the disease is summarized by Haskell in his special report as follows:

> "Regarding the seriousness of flag smut in both of these districts, it may be said that it is not causing farmers any loss. That is, less than 1% of flag smut has been found in all but about ten fields. However, it should be explained that lack of time prevented an accurate determination of the percentage of disease in the various fields. The field men were concerned principally with determining whether or not the disease was present and if found at all in a given field, the field was not inspected further but was reported as being infested. In a few fields spots were found where as high as 10% affected plants were observed and in one field in the Dupo section an average of 15% was recorded. One individual count in this field was as high as 25%. This was of course an exception and is the worst field that has thus far been found. It goes to show, however, that flag smut can become serious under the conditions existing in western Illinois.
>
> "There seemed to be a tendency for the disease to occur in spots and in some cases these spots were located near old straw piles where the threshing was done last year. Only one field was found in the Dupo area where more than a trace of the disease occurred and that field had 15%. In the Granite City Section about nine fields with from 1-2% were observed."

Agents in the dissemination of flag smut

Not a great deal is known about the dissemination of the pathogene. It has been suggested that it might be spread by water, but evidence accumulated

during the past season indicates rather clearly that water is an agency of only secondary importance in spreading the fungus. This is shown by the fact that a small island just south of Chauteau Island, one of the most severely infested areas, grows about 500 acres of wheat, and in spite of the fact that it is flooded each year, no flag smut has been found. Furthermore, in the Dupo section about two-thirds of the infested fields are on land approximately 200 or 300 feet above the River. Wind and threshing machines seem to be responsible for spreading the fungus to a great extent, and infection from the soil is very important. Smut developed in one field which was sown with seed obtained from Kentucky, indicating that infection must have resulted from the germination of spores in the soil. It seems quite probable, in view of what already is known about the dissemination of spores in the air, that many flag smut spores must be blown to considerable distances by the wind. Recently smut spores of various kinds were caught on spore traps, exposed on an airplane flying at an altitude as high as 12,000 feet. On one ordinary microscope slide exposed in this way, 60 smut spores were found in one clump. No flights for the purpose of exposing spore-traps were made near the flag smut infested area, but there would seem to be no reason whatever why these spores might not be blown to great distances during dust storms; or whirlwinds could carry the spores up several hundred, or even several thousand feet, where they could be blown easily for many miles by the upper air currents.

Control of flag smut

The methods of control consist in (1) quarantines, (2) seed treatment (3) use of resistant varieties, and (4) cultural practices. The control program which has been adopted in Illinois is summarized as follows by Haskell in his special report:

> "The Illinois State Department of Agriculture has decided on a vigorous control program to be carried out under the leadership of P. A. Glenn. This program in general is as follows:
>
> "(1) All grain is to be treated at the threshing machine as it comes from the separator by spraying it with concentrated formaldehyde at such strength and rate as will kill the smut spores and make the seed useless for planting purposes. One pint of formaldehyde and one pint of water to twenty-five bushels was used last year, but it is probable that this amount of solution will be applied to thirty-five bushels this year.
>
> "(2) Threshing machines are not to be used for threshing grain grown outside of infested areas if such machines have been used inside of the areas.
>
> "(3) Threshing machines inside of areas must be disinfected with formaldehyde before threshing oats or other grains the straw of which the farmer wishes to preserve.
>
> "(4) Machines that have been used for threshing wheat must be disinfected with formaldehyde at the close of the season.
>
> "(5) Farmers are required to plant such varieties

as the State Department of Agriculture shall recommend. These varieties will be those that have shown immunity during the past few years.

"(6) Seed is to be treated with copper sulphate and lime before planting in the fall.

"(7) Wheat straw is to be burned by September 1, 1921."

The flag smut situation in the United States

The following recapitulation of the situation in this country is taken from Haskell's unpublished report on the results of the flag smut survey in 1921:

"1. Another area where flag smut occurs has been discovered in Illinois. This is known as the Dupo Section and contains 57 infested fields on 30 farms.

"2. The original Granite City Section has been enlarged and extended this year by further survey, one hundred additional infested fields being found.

"3. Careful search for the disease on both sides of the Mississippi River from Cairo, Illinois to St. Louis, Missouri failed to reveal its presence except in the Dupo Section, and scouting in parts of the Missouri and Illinois River Valleys yielded negative results.

"4. Flag smut at present is not causing any appreciable loss, most of the fields showing only a trace, and about ten fields showing 1%. One field, however, contained 15% smut, manifesting the possibilities of the disease to become serious in this country.

"5. No evidence pointing to dissemination of the fungus by the river water was obtained. It is probable that spread in this way is not at all important. Observations of the field men show that the wind, threshing machines, and seed are the most likely agents of spore dissemination.

"6. The disease does not seem to have increased in severity during the last three years, but it seems to have been spreading steadily to new fields.

"7. Territory outside of, and adjacent to, the quarantined areas should be watched carefully in the future to prevent the escape of flag smut.

"8. The Illinois Department of Agriculture is conducting a vigorous campaign the most important phases of which are,- disinfection of grain at the separator, regulation of threshing machines, the planting of resistant varieties, and the disinfection of seed grain by the copper sulphate method."

The flag smut situation in Australia

The following summary of the Australian situation was prepared by Mr. R. J. Noble of the New South Wales (Australia) Department of Agriculture,

a graduate student at the University of Minnesota and collaborator with the Office of Cereal Investigations:

> "Flag smut occurs in all of the wheat growing areas of Australia with the exception of Western Australia, i.e., it is recorded from the states of South Australia, Victoria, New South Wales, and Queensland and extends over an area of about eight million acres. Infection up to 70% has been recorded in individual fields in Victoria, and during this 1921-1922 season losses up to 25% have been reported in certain areas of New South Wales. The average annual loss is estimated at about 3% for the whole of Australia representing a deficit of about three million bushels.
>
> "Because of the longevity of the spores and because practically all infection occurs from inoculum already in the soil, present control measures are at best only palliative.
>
> "Infection is always heaviest in the long season varieties and particularly when sowing is made in a dry seed bed.
>
> "Seed treatment by pickling in one and one-half per cent copper sulphate, effective as it is in the control of bunt, is, however, of no value if the soil is already infested with flag smut.
>
> "Control measures on the whole are as follows:
>
> "1. Crop rotation by which at the very least, two seasons intervene between successive crops of wheat while every effort is made to conserve soil moisture to induce germination of spores.
>
> "2. Burning of stubble in affected fields.
>
> "3. By feeding only disease-free hay and stubble to stock.
>
> "4. By sowing mid season and late varieties wherever possible in a well prepared seed bed.
>
> "Practically all the best commercial varieties,- e.g., Federation and Hard Federation types - are in the long season class and at the present time the short season resistant varieties cannot replace them except in a few of the districts throughout the wheat growing areas.
>
> "Experiments are in progress to test the efficiency of an extension of the dusting treatment in its relation to this disease."

Varieties resistant to flag smut

Since the spores may live in the soil for a considerable length of time it is quite evident that seed treatment, even with copper sulphate and lime, cannot be depended upon to control the disease entirely. For this reason, it is necessary to rotate crops and to use resistant varieties whenever possible. A list of resistant varieties is given on pages 126-128 in the Plant Disease

Bulletin, Supplement 15, issued May 1, 1921. Since that time, according to W. H. Tisdale, it has been found that Red Wave is not as resistant as it was originally considered to be. The other varieties, however, were as resistant in 1921 as they previously appeared to be. The following varieties seem to be suitable for use in the infested region of Illinois: Turkey Red (several strains), Fulcaster, Early May, Gypsy, and Nigger. Dungan recommends the use of Turkey 10-100, and Nigger.

Recent literature

Tisdale, W. H. and M. A. Griffiths. Flag smut of wheat and its control. U. S. Dept. Agr. Farmers' Bul. 1213: 1-6. May 1921.

Stem rust caused by Puccinia graminis Pers.

Stem rust (Fig. 40) was quite prevalent in 1921, but apparently it did not do as much damage as it did in 1919 and in 1920. In the New England states there was very little rust. In fact, none was observed in Connecticut or in New Hampshire, while in Vermont there was practically no loss from the disease. It is reported as having been fairly abundant, however, in Rhode Island. In New York, Pennsylvania, New Jersey, Delaware, Maryland, and West Virginia rust caused very little damage: the reduction in yield is estimated as a trace only. Both in New York and in Pennsylvania there was less rust than there was last year; in West Virginia there was a little more; in Virginia, according to Fromme, there was considerably more rust and it practically destroyed the wheat in some fields. Fromme's comment that the occurrence of rust was correlated definitely with the presence of native Berberis canadensis, is particularly interesting. All through the southeastern states the damage from rust was slight.

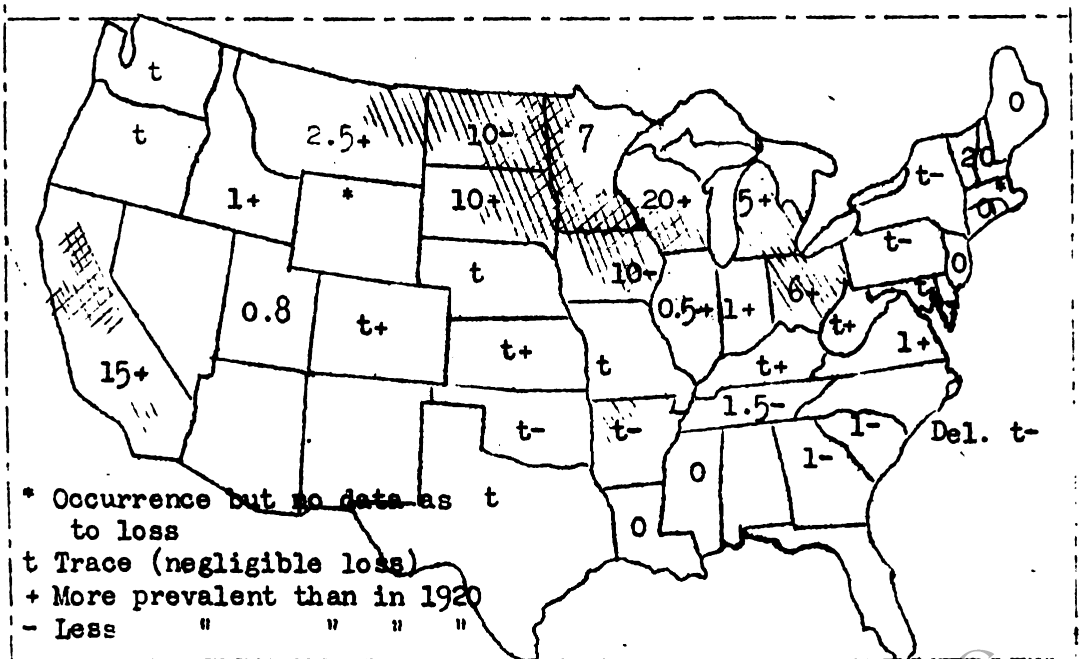


Fig. 40. Stem rust of wheat in 1921, prevalence and percent loss according to reports to the Plant Disease Survey.

In part of the soft red winter wheat region there was more rust than there was in 1919. In Kentucky, Ohio, Michigan, Indiana, and Illinois, stem rust was both more prevalent and apparently more destructive than in 1920, although the aggregate losses were rather small. Clayton estimates that the total yield in Ohio was reduced by 6%, while Coons estimates a 5% reduction for Michigan. In Indiana the loss was 1%, while the reduction in Illinois is estimated at .5%. The reduction in yield in Wisconsin is estimated by Vaughan to have been 20%; some of this undoubtedly was on spring wheat.

In the hard red winter wheat region rust was abundant but it developed too late to do much damage. Elliott reports that it was more prevalent than usual in northwestern Arkansas, although there was less for the state as a whole than there was in 1919. It is reported also as having been less severe than usual in Oklahoma, while in Texas it was apparently about average, or possibly slightly above the average. Melchers reports that there was more rust in Kansas in 1921 than in 1920, although the damage was slight. In Colorado there was much more rust than there was in the previous year although not much damage was done. The damage in the hard red winter wheat region would have been much greater had it not been for the fact that the grain matured early and thus escaped the rust.

The greatest damage was done in the hard red spring wheat region. The rust appeared earlier than usual and was fairly prevalent throughout much of this section by June 20. However, the unusually early harvest made it possible for the wheat to escape the greatest damage from rust. It was almost impossible to estimate accurately the reduction in yield due to rust in the hard red spring wheat region because the excessively hot weather and drought not only injured the wheat, but also caused it to ripen so early and so quickly that it was very difficult to differentiate between rust and weather injury. In most of the hard red spring wheat region, wheat was harvested two or three weeks earlier than in a normal season. In Idaho, Hungerford states that there was more rust than usual both in the northern part of the state and in the irrigated sections of the southern part. According to Barss there was a little more than usual in Oregon, but the loss was only a trace, and the same is true of Washington. In California, Mackie estimated that rust reduced the yield by 15%, which is considerably greater than the reduction in the average year. It is quite probable that the average reduction in yield in the two Dakotas and Minnesota was between 10% and 15%. Jennison reports that the rust was much more prevalent and destructive in northeastern Montana than it has been for many years, although the reduction in yield for the entire state was only 2.5%.

The following comments regarding the occurrence and severity of rust attacks are especially interesting.

Virginia: Quite localized, and determined by occurrence of native barberry, Berberis canadensis. Some fields too poor to warrant threshing, and fed for hay. (Fromme).

West Virginia: Quite severe in the southeastern part of the state. Mr. Berg found good evidence of its spread from sections where the barberry (Berberis canadensis) was found to sections some distance away. The disease evidently less serious and in an earlier stage in the distant fields. (N. J. Giddings).

Tennessee: (Observations made during April, May, and June in the vicinity of Knoxville, Murfreesboro, Columbia, Nashville, Jackson, and Union

City.) Stem rust in many fields could not be found at all, even in the latter part of May and early in June, that is, shortly before harvest time this year. Usually an occasional plant affected with the rust could be found, especially on the border plants that yet remained green. Only in one field, on the farm of the Normal School at Murfreesboro, the rust was found, June 4, in a severe form in the low part of one field. The rest of the field, in the higher part of it, was nearing full maturity and was practically free from the rust. The wheat specimens brought in by the Knox county agent and his information in regard to other fields showed that some fields in east Tennesssee were seriously injured by the rust, the damage in some exceptional fields being as high as 30%. The damage for the state would be considered at about 3%. (C. D. Sherbakoff).

Arkansas: More than usual, probably little damage. (Elliott).

Kansas: A heavy infection was under way when hot, dry weather prevented its further spread. (Melchers).

Ohio: This rust appeared late but from June 10 on it was found in the majority of fields visited. It did little damage over the state as a whole. In certain sections of South Central Ohio, however, the attack was severe and the loss heavy. (E. E. Clayton).

In June it was not at all difficult to find a large sprinkling of black stem rust in almost any wheat field in central and western Ohio. However, it was not generally present to a damaging degree. A very few instances of serious damage from black stem rust have been reported. All reports of serious damage from stem rust, which have been investigated to date, have shown that escaped common barberries were responsible for the attacks. It is hard to account for the general light sprinkling of black stem rust over extensive areas. (John W. Baringer).

Indiana: By the end of July the barberry survey of all counties in the extreme northeastern part of the state has been completed, thus rounding out a block of territory made up of northeastern Indiana, southern Michigan, and northwestern Ohio. All of DeKalb and Steuben Counties and the balance of LaGrange County were covered during this month. During this period some of the most striking cases of the spread of rust from the barberry which have been observed since the campaign began in Indiana were discovered. In one instance a single bush in the front yard of a farm in DeKalb County was found to have spread rust to about 25 acres of wheat within a radius of a mile. One of these pieces of wheat consisting of about 15 acres on the farm of the man owning the barberry bush, was being thrashed on the day the bush was discovered. No further argument was necessary to convince the men that were thrashing this rusted grain that the barberry should be removed. (R. J. Hosmer).

Rust local; severe only near barberries. (Jackson).

Illinois: Heat wave hastened ripening and reduced rust damage. Direct connection between presence of rust in northern Illinois and presence of infected barberries. (Dungan and Tehon).

Michigan: Southeastern Michigan, Monroe County, slight, if any; Lenawee, limited outbreaks, damage 5%, very slight except in direct relation to barberries where reduction in yield was 40%. Northern and Central parts of Lower Peninsula, slight rust. Upper Peninsula, severe, loss in general 15%. (Coons).

Wisconsin: More rust in vicinity of escaped barberry. Winter varieties little damaged. Damage checked by drought. (Vaughan).

Minnesota: First report on wheat about June 15, from Dakota County. Found on grasses on May 29. The rust came early and developed rapidly until the excessively hot weather in June checked its development and spread. Under favorable weather conditions there would have been a very severe epidemic, since the rust started earlier than usual and was universally present. However, the hot weather not only checked the development and spread of the rust, but ripened the wheat prematurely so that the damage caused by rust was not as serious as that caused by heat. It is almost impossible to estimate the relative amount of damage done by the rust and by the heat. (Department of Plant Pathology).

North Dakota: Puccinia graminis has again wrought great damage in the Red River Valley district of North Dakota and western Minnesota. It at first started in a spotted irregular manner indicating perhaps that our campaign for the eradication of the common barberry has had good effect locally. The first infections came on earlier than in previous years. The second infection came along normally, but what I call the general or final infection it seems did not get into full action. This was probably prevented by the intense drought and hot weather, otherwise, we should have had a very thorough repetition of the destruction by rust as shown in 1916. (Bolley).

Montana: Prevalent in northeastern Montana again this year for the first time since 1916. Distribution appears to be limited to following counties: Richland, Roosevelt, Sheridan, Valley, Phillips, Blaine (eastern part), Dawson (northern part), McCone (northern part). Infection varies from about 10% to 50%, becoming less to west and south in affected area. (H. M. Jennison).

None found in winter wheat crop. (Jennison).

Colorado: Very prevalent over the state in both the irrigated and dry land sections, but it came too late in the season to cause much damage. On the 24th and 25th of June, I found it in but two fields in a 160-mile drive, while on July 11 I made a one day trip covering much the same territory as on previous trip and it was from just present to 75% infection in every field inspected. This trip was made throughout both irrigated and dry land farming sections. It was very prevalent on the station farm and the variety plots, but it was much worse on the club wheats than other varieties. (Learn).

(June 30) - Nearly all fields examined showed leaf rust but little stem rust. Reports have been coming in from Weld and Logan Counties that about 50% of the wheat is being lost from stem rust. Our field men reported that leaf rust was heavy in these sections

but no stem rust. During July the pathology department of the college will survey these districts to determine whether leaf rust or stem rust is present.

(July 30) - Baca, Cheyenne, Kit Carson, Lincoln, Morgan, and Kiowa Counties) Black stem rust is quite widely distributed throughout this country on the spring wheat. The winter wheat matured early enough to avoid the rust, which seemed to enter the state from the east and southeast. Close observation of the stem rust situation showed that the spread was from the eastern border, where it was first noticed about June 10. Field observation taken along the foot-hill section west of Denver July 29 showed very little stem rust in either the winter or spring wheat. (John R. Fitzsimmons. Cereal Courier 13: 159-160. Aug. 10, 1921.)

Idaho: Much more prevalent than usual in all parts of the state. Appreciable damage resulting in some irrigated sections of south Idaho. (Hungerford).

Barberry infection.

One of the outstanding features of the development of stem rust during 1921 was the fact that barberries became very heavily infected early in the season (see Table 25 for dates of first appearance). A plant of Berberis trifoliolata became heavily infected at San Antonio, Texas as early as March 12. This bush had been inoculated with teliospores which had been formed at Boerne, Texas, but which had been kept at St. Paul, Minnesota during the summer and fall. The earliest record of natural infection of barberries was made by Fromme at Blacksburg, Virginia, where pycnia were found on native Berberis canadensis on March 29. Barringer found rusted barberries in Ohio April 16 and within a week infected bushes were found in several states. In Minnesota many bushes already were rusted on April 25. By May 15 barberries were quite generally rusted in the upper half of the Mississippi Valley and they were found infected as far north as Winnipeg, Manitoba, as early as May 23. In Colorado and Wyoming, on account of the high altitudes, barberry bushes did not begin to rust until late in May. The freeze which occurred in some of the Lake States killed many of the infected leaves on barberries but the new leaves soon became infected also. By the end of May rust already had spread to grasses and grains from the rusted barberries in many places.

Development of rust in the South

Rust did not develop especially early in the South (Table 25). Conditions had been favorable for rust development in parts of Texas during much of the winter. This is pointed out clearly by Prof. Wallace Butler, who inoculated wheat, growing in small plats in San Antonio, on January 21. By February 5 uredinia had appeared and by March 15 the plants were heavily rusted. But uredinia were not found in fields of oats near San Antonio until April 19 and on May 12 there was only a slight trace near Dallas, where there was also a trace on wheat. It seems quite likely, therefore, that there was insufficient inoculum to enable the rust to develop early.

The rust apparently did not develop in northern Kansas or southern Nebraska until about June 10. By June 15 there was a fairly general sprinkling of rust almost throughout the Lake states and in much of the hard red spring wheat region.

Table 25. Dates of first appearance of stem rust, - 1921.

Aecia on Barberry			Uredinia			
Date	Place	Observer	Date	Place	Host	Observer
Mar. 12	San Antonio, Tex (1)	Butler				
Mar. 29	Blacksburg, Va. (2)	Fromme				
Apr. 16	Greenville, Ohio	Barringer				
" 18	Xenia, Ohio	"	Apr. 19	San Antonio, Tex.	Oats - 1-2%	Christopher & Butler
" 25	Heron Lake, Minn.	Melander	" 21	Boerne, Tex.	" t	Butler
" 26	Blair, Nebr.	Thiel				
" 30	Corvallis, Ore.	Hoerner				
May 2	Ithaca, N. Y.	Kirby				
" 3	Rock Co., Wisc.	Thompson & Clark				
" 3	Woodstock, Ill.	Schulz				
" 3	Harrison Co., Iowa	Carmichael				
" 7	St. Joseph Co. Mich.	Klotz				
" 10	Brookings, S. Dak.	Gilbert & Hutton	May 12	Dallas, Tex.	Wheat - t	Stakman & Christopher
" 16	Tippecanoe Co., Ind.	Hosmer		" "	Oats - t	" "
" 23	Winnipeg, Manitoba	Bisby	" 19	Saltillo, Mex.	Wheat, oats, barley (3)	" "
June 1	Fort Collins, Colo.	Fitzsimmons	" 27	Denton, Tex.	" " "	Christopher
" 1	Cheyenne, Wyo.	Cotter	" 28	Durant, Oklahoma	Oats (h), wheat (t)	"
" 8	Dunn Center, N. Dak.	Mayoue	" 28	Copas, Minn.	Agropyron repens (4)	Christensen
" 9	Beaver Creek, Mass.	Jean MacInnes	" 30	Trempealeau, Wis.	Oats, wheat (4)	Thompson
" 9	Concordia, Kans.	Curran	" 31	Ardmore, Okla.	Wheat, oats	
			June 1	Knoxville, Tenn.	Wheat	Mains
			June 3	Lawton, Okla.	Wheat, barley, oats	Christopher
			" 3	Black Earth, Wis.	Oats, wheat, quack	
					grass, red top (4)	Thompson
			" 4	Preble Co., Ohio	Wheat - winter (t)	Baringer
			" 4	Marysville, Kans.	Wheat, oats, rye	Thiel
			" 5	Hastings, Nebr.	" ", "	"
			" 6	New Ulm, Minn.	Wheat - winter (t)	Ostrom & Hinckley
			" 7	Ames, Iowa (5)	Wheat	Melhus
			" 10	Vevay, Ind.	Oats (h)	Jackson
			" 13	Chatham, Mich.	Wheat - winter (t)	Kotila
			" 13	Fargo, N. Dak.	Wheat - spring (t)	Weniger
			" 14	Lincoln, Nebr.	Wheat, rye, oats (l)	Thiel
			" 14	Montgomery Co., O.	Wheat (h) (6)	Baringer
			" 15	Miami Co., Ohio	" (m)	"
			" 15	Belleville, Ill.	Wheat - winter (t)	Henry

(1) Berberis trifoliolata inoculated with telia developed at Boerne, Tex., and kept in North until fall; (2) Pycnia on native B. canadensis; (3) Infection probably had occurred at least a month earlier; (4) Near rusted barberry; (5) At several other places also; (6) Extremely heavy infection on wheat, telial stage, result of the spread of rust from barberries near West Carollton, Ohio, Montgomery County. Scattered light infection several places within radius of twenty miles from Dayton. All stem rust noticed attributed to barberry. (Baringer); (7) t=trace of rust - l=light infection - m=moderate infection - h=heavy infection.

At that time the rust was still rather light in Kansas and in Nebraska. Urediniospores of Puccinia graminis as well as spores of many other fungi are common in the air at elevations up to 10,000 feet above the surface. While the work upon which these conclusions are based (4) was not extensive enough to make it possible to make any definite statement regarding the movement of rust from south to north, it is quite possible that rust spores can be carried great distances by the wind. This would apply to urediniospores developed in the south as well as to those developed near barberries in the north. Just how long these spores retain their viability in the air is not known.

It is significant that barberries rusted in the north as early or even earlier than the uredinial stage of the rust developed commonly in the extreme south. Table 25 lists the dates when stem rust was first observed on barberries, cereals, or grasses. The first infections on common barberry were found about April 15. Observations made at Saltillo, Coahuila, Mexico, indicate that the uredinial stage of rust probably had begun to develop there at about the same time.

Relation of weather conditions to stem rust development

The weather apparently was quite favorable for the early development and rapid spread of rust in most regions early in the season, but later it became quite unfavorable. Temperatures were above normal almost throughout the country during March, and the total precipitation in the Mississippi and Ohio Valleys was greater than normal. The same thing was true in many regions in April. The abnormally high temperatures and the heavy precipitation probably accounted for the early appearance and the general prevalence of the rust on barberry. During May the weather was in general warm, although there was a cold wave over part of the upper Mississippi Valley about the middle of the month. The temperatures in June were for the most part far above normal, although there was a very wide range. The precipitation in the spring wheat region was somewhat below normal, but most of the rain occurred during the first half of the month, when there were many showers. Furthermore, hot days often immediately followed fairly heavy showers, and, in some regions, there actually was an excess of precipitation. The range in temperature, together with high temperatures accompanied by rain, probably accounts for the rapid development of the uredinial stage of the rust during the second decade of June. During the latter part of the month the temperatures in general were excessively high and there was but little precipitation with a great deal of sunshine. These conditions enabled the rust to develop rather rapidly. The excess of temperature over normal in South Dakota was 6.9°, in Minnesota 6.2°, and in North Dakota 5.4°. The precipitation was higher than normal in Colorado, Wyoming, Missouri, Kansas, New Mexico, Arkansas, Oklahoma, Texas, and Louisiana. By the end of June all the grain in the hard winter wheat region already had been cut. Consequently, the weather conditions for the first part of the month only were important as affecting the amount of rust in that region. The month of July was hot and in general it was rather dry, although there were excessive rains in some localities. Since spring wheat usually is not cut until about August 1, July weather is very important in determining the development of rust. In the Lake States the temperature was on the average 6° above normal, while in Minnesota it was 5.1° above normal. In some of the districts of the spring wheat region the rainfall also was excessive. At La Moure, North Dakota for instance, there were ten inches of rain, and in South Dakota not only was the heat excessive but the precipitation was above normal in the

northeastern counties. However, the effect of the weather in general was to ripen the grain prematurely and thus prevent the greatest amount of rust damage. The crop was harvested from two to three weeks earlier than it normally is and it is rather difficult, therefore, to determine just how much damage rust did and how much the hot weather did. In general, however, it would seem that the weather was extremely favorable for the development of rust until the latter part of June, after which it became unfavorable for the development both of rust and of wheat, except in those localities in which the heat was accompanied by high precipitation.

Progress in barberry eradication

The following summary on the progress of the barberry eradication campaign, by F. E. Kempton, Pathologist in Charge of Barberry Eradication, Office of Cereal Investigations, is especially interesting:

> "The cooperative campaign for barberry eradication conducted by the U. S. Office of Cereal Investigations in Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming has advanced through its fourth field season.
>
> "During 1918, an organization was formed, a wide-spread campaign of publicity and education conducted, and surveys to locate bushes were begun.
>
> "In 1919, the city and village surveys were almost completed and a systematic farm-to-farm survey completed in about 90 counties.
>
> "In 1920, a re-survey of cities and villages was conducted and the farm-to-farm survey completed in 88 more counties.
>
> "In 1921, farm-to-farm survey, with re-survey of included cities and villages was completed in 142 counties. Of those, 23 counties in Minnesota were surveyed on funds furnished by the state and 165,662 bushes were found on 5,053 properties and 199,647 bushes were removed from 6,317 properties. Investigations were begun on chemical methods of eradicating both mature bushes and seedlings. See Table 26 for the year's results.
>
> "From April I, 1918 to October 31, 1921, all states in the eradication area provided themselves with laws compelling barberry eradication; almost all cities, towns, and villages therein were surveyed; and an area of approximately 321 counties was covered in the farm-to-farm survey with necessary re-surveys in a portion of these counties. The original survey is completed in Montana, Colorado, and Wyoming. A total of 5,619,971 bushes was located on 49,926 properties. Of these, 4,443,826 bushes were removed from 45,584 properties. These results include 10,000 bushes found and removed from 20 properties in cities and towns in North Dakota in 1917 which have not been included in previous reports. Of the 1,176,145 bushes remaining on 4,342 properties, about 1,000,000 are escaped bushes, most of which are under 18

inches in height on 3 large escaped areas in Wisconsin. See table 27 for the results of the entire campaign."

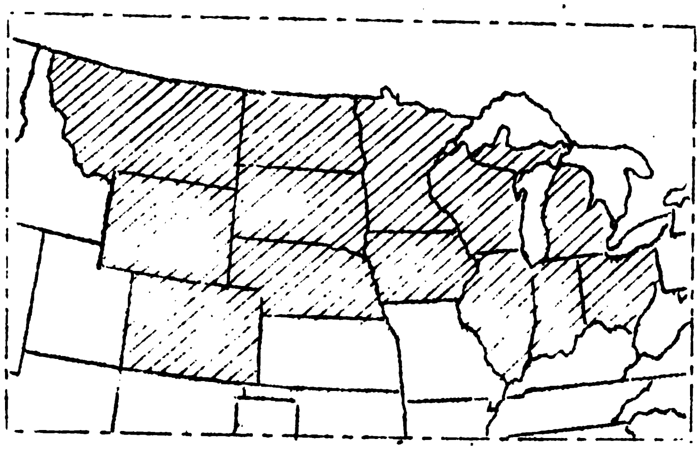


Fig. 41. Barberry eradication area (shaded portions).

Table 26. Data showing results obtained (number of bushes found and removed) in the barberry eradication campaign from January 1 to December 31, 1921.

State	Number of bushes: In cities and towns	Number of bushes: In country: Escaped	Number of bushes: In country: Total	Number of bushes: In both cities and country: Found	Number of bushes: In both cities and country: Removed	Sprouts found and removed re-survey
Colorado	607	14	299	906	1,212	630
Illinois	12,835	23,434	33,203	46,038	31,030	1,675
Indiana	263	1,732	2,312	2,575	2,424	608
Iowa	54	2,943	7,073	7,127	11,937	3,619
Michigan	3,409	18,217	28,220	31,629	27,602	144
Minnesota	630	2,641	7,143	7,773	8,022	5,265
Nebraska	296	2,384	6,281	6,577	14,741	1,951
North Dakota	298	150	1,925	2,223	2,223	276
Ohio	3,360	4,565	5,645	9,005	25,475	2,281
South Dakota	299	5,168	9,550	9,849	8,803	655
Wisconsin	1,201	39,411	40,719	41,920	65,628	4,802
Wyoming	14	0	26	40	550	50
Total	23,266	100,659	142,396	165,662	199,647	21,956

Valleau states that in experiments at Lexington, Kentucky, Ashland (a selection from New Jersey Fultz) proved practically immune from stem rust, while other strains of the same variety were severely attacked. Every field of Marquis wheat examined by scouts of the barberry eradication campaign in Griggs, Foster, and Eddy Counties in North Dakota was badly damaged by stem rust, the reduction in yield ranging from 10-40%, while in the same area reduction in yield of durum wheats was about 5%, according to George C. Mayoue (Cereal Courier 13: 201. Sept. 10).

Table 27. Data showing results obtained (number of bushes found and removed) in the barberry eradication campaign from April 1, 1918 to December 31 1921.

State	Number of bushes: In cities and towns	In country: Escaped	In country: Total	In both cities and country: Found	In both cities and country: Removed	Sprouts found and removed in the re-survey
Colorado	19,172	1,411	3,376	22,548	22,457	3,226
Illinois	92,500	25,635	42,289	134,789	114,897	2,336
Indiana	75,288	4,173	12,446	87,734	86,342	2,460
Iowa	642,544	32,216	89,196	731,740	731,545	6,502
Michigan	39,360	76,960	131,916	171,276	119,878	189
Minnesota	588,734	53,509	152,574	741,308	741,087	15,427
Montana	6,577	1	2,105	8,682	8,671	4,515
Nebraska	71,296	3,185	12,338	83,634	82,934	3,276
North Dakota*	14,080	150	3,035	17,115	17,115	491
Ohio	197,120	19,774	25,747	222,867	199,367	2,281
South Dakota	22,223	14,407	23,812	46,035	38,908	1,568
Wisconsin	276,673	3,063,763	3,071,430	3,348,103	2,279,583	13,086
Wyoming	3,946	1	194	4,140	1,042	240
Total	2,049,513	3,295,185	3,570,458	5,619,971	4,443,826	55,597

*The results for North Dakota include 10,000 bushes found and removed from 20 properties in cities and towns in 1917 which have not been included in previous reports.

Varietal susceptibility

Data concerning susceptibility of wheat varieties to stem rust are summarized in Table 28.

Table 28. Varieties reported as susceptible or resistant to stem rust of wheat, 1921.

Resistant	Susceptible
Ashland (a selection of Jersey Fultz), Kentucky	Other strains of Jersey Fultz, Kentucky
Kanred, Michigan	Fulcaster, Tennessee
Durum wheats, North Dakota	Marquis, North Dakota
	Kharkof, South Dakota
	Club wheats, Colorado
	Hard Federation, California
	White Federation, California

Experiments conducted at the Kansas (2), Minnesota (1,3), and North Dakota (4) stations with a view to producing resistant hybrid varieties have shown promising results.

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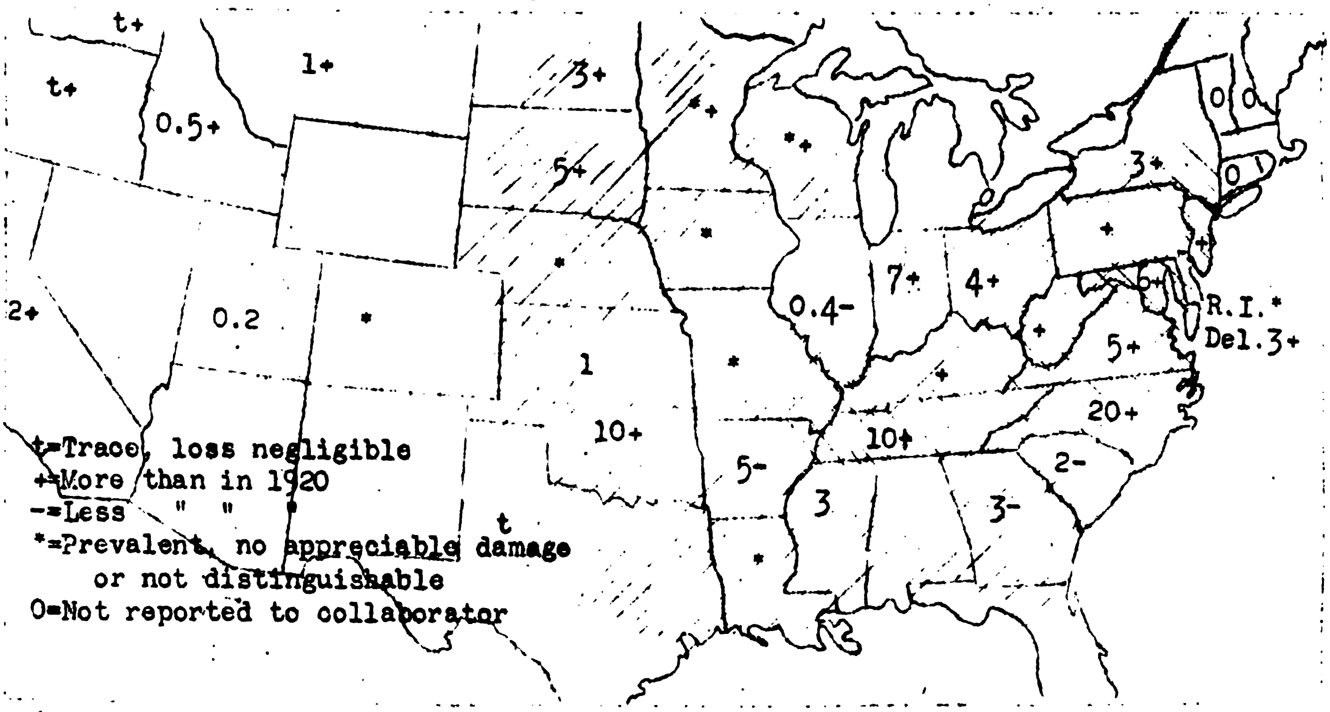
Leaf rust caused by Puccinia triticina Eriks.

Leaf rust of wheat was much more prevalent and destructive in 1921 than in 1920. In fact, it probably was more severe than it has been for several

years. Fromme, for instance, states that there was more rust in Virginia than there has been during the past six years. The rust developed quite abundantly on wheat in the fall of 1920, and in the South it continued to develop, at least to a slight extent, practically throughout the winter. At Brownsville, Texas, for example, on January 3, 1921 there was a considerable amount of leaf rust on the wheat. Several collaborators comment on the fact that the rust appeared to be heavy on wheat late in the fall, that a trace could be found throughout the winter, and that it appeared very early in the spring of 1921.

Importance of leaf rust in 1921

While the rust was more prevalent than usual in practically all of the states east of the Rocky Mountains from which reports were received, with the exception of South Carolina, Georgia, and Arkansas, it apparently did most damage in New York and the states along the Atlantic Seaboard south to South Carolina, also including Tennessee, Indiana, and Ohio. West of the Mississippi apparently the rust reduced yields considerably in Arkansas and in Oklahoma. Foster estimates that the yield was reduced by 20% in North Carolina. The next highest percentage of reduction is 10% in Tennessee and New Jersey. Jackson estimated a 7% reduction in yield in Indiana, while in Ohio and Virginia the estimated reduction is about 5%. In Maryland, Temple estimates that the yield was cut 6%. Several collaborators comment on the difficulty of differentiating rust injury from the injury caused by unfavorable weather conditions.



(Note apparent correlation of rust occurrence with production of soft red winter wheat.)

Fig. 42. Occurrence of leaf rust of wheat in the United States and estimated reduction in yield in 1921.

Just how much of the reduction in yield is attributable to the rust and how much to the hot weather and drought, cannot be stated definitely. The situation may be somewhat similar to that with respect to the stem rust. Unfortunately, whenever rust is very destructive weather conditions also are likely to be unfavorable for the best development of the crop, consequently, it is difficult to evaluate the factors accurately. However, there seems to be a general unanimity of opinion that this year the leaf rust did a considerable amount of damage in much of the soft-red winter wheat area; in New York, Pennsylvania, Maryland, Delaware, Virginia, North Carolina, Tennessee, Kentucky, Ohio, Indiana, Arkansas, part of Oklahoma and Missouri, and eastern Kansas. The map (Fig. 42) gives estimated losses from leaf rust in 1921.

The area in which leaf rust is most destructive does not coincide with that in which stem rust does the greatest damage. By referring to the stem rust map (Fig. 40), it will be seen that the greatest damage was done by the disease in Ohio, Michigan, Wisconsin, Minnesota, the two Dakotas, Northeastern Montana, and California. However, it is exactly in these states in which the leaf rust was of minor importance, with the exception of South Dakota and Ohio, in which the leaf rust is estimated to have caused a reduction of about 5% in yield while the stem rust caused a reduction of 6% in Ohio and 10% in South Dakota. However, while the reduction in yield in Michigan, Wisconsin, Minnesota, and the Dakotas, due to stem rust, was from 5% to 20%, the reduction in yield in these states due to the attacks of leaf rust was almost negligible. This cannot be explained on the basis of date of appearance of rust. Leaf rust was found on winter wheat in Minnesota as early as May 2, and no stem rust had appeared at that date except in the aecial stage on barberries. It seems quite likely that the true reason for the comparatively insignificant damage from leaf rust in the hard red spring wheat area is that many of the hard red spring wheats and durum wheats are quite resistant to leaf rust. Marquis, for instance, the most commonly grown bread wheat in the hard red spring wheat region, rusts only about half as much, on the average, as the most susceptible winter wheat varieties. The uredinial stage of the leaf rust overwinters commonly in the hard red spring wheat region, as it does in practically all other parts of the United States. The mild winter and the early spring this year enabled the rust to start early and to develop epidemic proportions before harvest time. Some of the hard red winter wheats of the Crimean group also are quite resistant to leaf rust, and therefore usually are not severely injured. Most of the soft red winter wheats, on the other hand, are quite susceptible and the greatest damage in general seems to occur in the region in which they are grown. The situation in California is rather interesting. Stem rust, which is known to overwinter in certain districts, caused a reduction in yield of 15%, while leaf rust which overwinters much more readily and under more unfavorable conditions than does the stem rust, caused a reduction in yield of only 2%. Possibly varietal susceptibility also may account for this fact. It seems to be true that the leaf rust is much more infectious than the stem rust: it apparently can develop under a wider variety of conditions and thus spreads more rapidly. It is quite likely, therefore, that varietal susceptibility is the determining factor in its distribution.

A few of the early dates of appearance of leaf rust are given:

Brownsville, Texas, Jan. 3	Wichita, Kansas, April 6
Johnson County, Kansas, March 2	Pawnee & Perry, Okla., Apr. 8
Dewitt, Nebraska, April 4	Dallas, Texas, Trace to 100%
Knoxville, Tennessee, April 4	April 9.

The following comments on the occurrence and destructiveness of leaf rust are particularly interesting:

New York: The leaf rust of wheat was especially severe in 1921. The epidemic of leaf rust seems to have been caused by a very mild 1920-21 winter and the exceptionally early spring which allowed this rust to get a very early start. It seems very likely that leaf rust may have caused at least 5% loss to the New York wheat crop. (Kirby).

Delaware: First reported this season April 8. Considerable infection was found on young plants as late as December, last year. Has been very severe this season. Fields appeared prematurely ripening as result of severe leaf infection. Infection on glumes common and many fruits found with sori at the crown. (Manns).

Virginia: More epidemic than I have ever observed it before. Especially severe on early sown wheat. This injury combined with that caused by late frosts probably caused greater reduction in yield than any other single agency. (Fromme).

West Virginia: Leaf rust seemed to have done the most damage this season, perhaps due to the unusually mild winter. This trouble was considerably aggravated by a dry spell that followed after the wheat headed. (Berg).

Tennessee: Leaf rust showed its appearance this year much earlier than usual. During the first week of April in the earliest and best wheat fields around Columbia, the infection was from 50-80%, and in May and June the infection in most of the fields ranged from 60-100%, averaging probably about 90%. The actual damage caused by the rust is very hard to estimate and may be guessed at about 10%, ranging from very light, in the case of late fields and somewhat rust-resistant wheat varieties, to probably close to 40% in the case of the earliest fields and with the susceptible varieties. (Sherbakoff).

North Carolina: In Buncombe County I covered a large area. The general opinion of the growers and county agents was that the wheat crop this year was the poorest they had seen in years, due partly to unfavorable weather conditions but mostly to the damage done by the leaf rust and Hessian fly. The two most common and universal diseases found in this county were leaf rust and Septoria.

........The wheat crop was very poor in Wilkes County, due to the unfavorable weather, the fly, and the rust.

In the other counties visited,- namely Surry, Alexander, Yadkin, Forsyth, Rockingham, Guilford, and Durham - the wheat was very poor also. The only diseases commonly found were the rust and Septoria. (Foster).

Oklahoma: Crop sown late has less rust and bids fair to outyield the early sown. Rapid deterioration noted in crop generally on account of orange leaf rust and dry soil. (Bu. Crop Est. Crop Notes, week ending May 14.)

The rusts have been very bad this year, especially the orange leaf rust, practically all fields of wheat being badly infected with it, usually 40-65% according to the chart. Kanred and Black Hull Turkey varieties showed usually about 10%, showing much resistance to the rust. (Stratton).

Kanred and black Hull Turkey least susceptible. (Stratton).

Ohio: The attack has been very severe and in many fields seemed to be responsible for the premature ripening. It is very difficult, however, to estimate damage from this disease. (Clayton).

The attack has been very severe and the farmers feel that it has cut the yield more than any other one thing in many cases. Certain it is that in those areas worst affected they are only threshing out from three to ten bushels of wheat to the acre. Extreme southern Ohio was worst affected. (Clayton).

Indiana: Leaf rust has been very severe, more so I think than in any year since I have been in Indiana. It is practically universally present, so much so as to be commented on in the papers, and has attracted a good deal of attention. Opinions differ as to the loss and it is of course very difficult to get at anything tangible in this connection. I am convinced, however, that there has been considerable loss from the leaf rust this year, particularly where the infection occurred early. (Jackson).

Illinois: The men engaged on flag smut survey in the bottom lands of the Mississippi River during May and June found leaf rust very abundant and, according to growers, it was much more serious than usual. In many fields the wheat kernels were slightly shriveled and the heads were not entirely filled. Leaf rust may have been partially but probably not wholly responsible for this condition. (Haskell).

Universally distributed where spring wheat was grown in Illinois. It ran as high as from 25 to 40%, according to the U.S.D.A. scale for estimating rust. (Dungan).

Wisconsin: Widespread. Destructiveness questionable. (Vaughan).

Minnesota: First report May 6 in Ramsey County. The leaf rust on wheat came early this year and was much more prevalent than it usually is. The degree of infection ranged from trace to 100%. As far as has been determined, no damage was done. This likely is partly due to the fact that most of our spring wheat varieties are moderately resistant to the disease. Furthermore, the hot weather checked the development of the rust and probably prevented it from doing appreciable damage. (Department of Plant Pathology).

Missouri: Mr. Curran of the rust survey of the Office of Cereal Investigations, examined the wheat and oats on the Station field today. A small amount of leaf rust was found on most of the varieties of wheat and rye but no stem rust was detected. (L. J. Stadler, Columbia. Cereal Courier 13: 72. May 10.)

North Dakota: Leaf rust has been generally and rather evenly distributed throughout the state, starting early in the spring, and in many cases caused a large amount of defoliation, particularly on some varieties which are otherwise quite resistant to stem rust. (Bolley).

The first appearance of Puccinia triticina was observed on May 27 on Kota and Acme wheats. (W. E. Brentzel. Cereal Courier 13: 103. June 10.)

South Dakota: Leaf rust is very abundant. In many cases it is doing serious injury to the grain, I feel sure. On many of our plots every leaf is dead yet the grain seems to be filling rather well. I can't conceive, however, of its filling entirely without shriveling under these conditions. (Evans).

Very severe. Some fields a few per cent, many fields 100%. Must have done some damage although I found no shriveling directly traceable to it. (Evans).

Kansas: Soft wheat has been injured to some extent by red leaf rust in eastern Kansas.

Field inspection of Kanred wheat has been completed except for some fields of Kanred in extreme northwestern counties which will be inspected the last week in June. Kanred is again manifesting a remarkable degree of resistance to leaf rust in all sections of the state. (John H. Parker. Cereal Courier 13: 125. July 10.)

Montana: Significant damage in certain localities; never so common before. (Jennison).

More or less common throughout the state where spring wheat crop amounts to anything. In more moist districts considerable amounts of winter wheat leaf tissue killed. (Jennison).

Colorado: Practically over the entire wheat section. More common on dry land than irrigated. (Learn).

Washington: Present in severe form in some fields especially on some of the club hybrids. (Heald).

Oregon: General; more than usual or than last year; reduction a trace. Found in 90% of the fields in the state. In the Willamette Valley as many as 100% of the plants heavily affected in some fields. First noticed May 28 at Melrose. (Barss).

California: Puccinia triticina was very abundant in nearly all wheat fields but was more pronounced in the Sacramento Valley and Delta regions where damage resulted, especially in spots of lodged grain. (Mackie).

Both Hard and White Federation are susceptible to the common leaf (triticina) rust. (V. H. Florell, Cereal Courier 13: 106. June 10.)

Mexico: Fairly prevalent but not destructive. (Stakman & Christopher).

Varietal resistance

The following summary of varietal resistance was supplied by Dr. E. B. Mains:

"In general the most resistant of the bread wheats are the hard winter varieties of the Crimean type. Certain strains of Malakof, Hungarian, Banat, Budapest, Kharkof, Beloglina, Crimean, Turkey, Eversole, Kanred, Kansas P 1066, and Kansas P 1068 have shown high resistance in one or more of the plantings mentioned above, the last three of these varieties being highly resistant in all. These wheats, of course, are not well adapted to eastern conditions and although we do not have so many varieties among the softer winter wheats showing as high a resistance as the above, yet certain strains of Mediterranean, Red Hussar, and Imperial Amber are giving considerable promise, showing up especially resistant at Arlington this past season. Our work would indicate that a number of other strains of soft winter varieties, while not highly resistant, still are only moderately susceptible. Those showing the most promise are certain strains of Fulcaster, Fultz, Currell, Michigan Amber, Red Cross, Pennsylvania 44, and Blue Ridge. The spring wheat varieties, Haynes Bluestem, Preston and Marquis in general show this moderate susceptibility.

"Among the wheat species the Emmers are usually more or less resistant, especially Khapli and Black Winter. The Spelts are also rather highly resistant, especially Alstrom, Red Winter and White Winter. In a similar way the Durums usually show considerable resistance, especially Acme, Arnautka, D5, Goose, Mindum and Monad. The one strain of Rivet and Emmer tested were both highly resistant. The Club wheats, so far as we have tested them, are all extremely susceptible with the exception of a little grown variety known as Binkel Club, which has shown moderate susceptibility.

"This covers in a general way the situation for the eastern part of the country. The presence of three or four strains in this region, of course, complicates the situation. Further study will doubtless be necessary in order to definitely establish whether these varieties will maintain their value, but I think there is no question but what the disease can be considerably decreased by a number of the more promising and that still more highly resistant varieties can be obtained by hybridizing."

Recent literature

Jackson, H. S., and E. B. Mains. Aecial stage of the orange leaf rust of wheat, Puccinia triticina Eriks. Jour. Agr. Res. 22: 151-172. Pl. 21. Oct. 15, 1921.

Stripe rust caused by Puccinia glumarum (Schm.) Eriks. & Henn.

During the past year stripe rust was found only in Montana, Idaho, Washington, Oregon, and California. None was found in South Dakota, where it

was found on barley several years ago. Dr. Arthur W. Evans made a very careful search for stripe rust during the past season but was unable to find any trace of it. Therefore, it is evident that the disease is not spreading eastward very rapidly. The real reason for the failure of the rust to spread eastward would furnish the subject for some interesting experiments.

In the region in which the yellow stripe rust occurred in 1921, it did but little damage. Jennison reports that it was very common on Crail Fife in irrigated sections of Montana, that it was particularly prevalent where the ground was low, and that it did some damage by killing leaf tissues. However, he states that the damage for the state was negligible. Hungerford reports that stripe rust was more prevalent in Idaho than it has been since 1915. It seems to be most common in the northern part of the state, in which scarcely a wheat field is free from the rust. However, Hungerford states also that the damage was very slight. Heald reports that the rust occurred in Washington but that there was only a small amount and apparently no appreciable damage was done. In Oregon, according to Barss, the disease was more prevalent than usual but unimportant. Jenkins Club and Forty-fold were the varieties most severely affected in the fields surveyed in the state. D. E. Stephens reports as follows in the Cereal Courier 13: 186. June 10, 1921.

> "A little stripe rust is present (at Moro, Oregon) on some of the winter wheats, one of the Forty-fold x Federation hybrids in the nursery having an especially heavy infection. Adjacent rows of cross between Turkey and Karun show no infection yet."

V. H. Florell (California) contributed the following (Cereal Courier 13: 106. June 10.):

> "The White Federation was found to be a particularly congenial host to the yellow stripe (glumarum) rust. Stripe rust was observed on this variety at all points except two where the drought was most severe. Stripe rust is rarely found on Hard Federation."

Dr. H. B. Humphrey states that the rust was very prevalent in the experimental plots at Corvallis, Oregon, and that some varieties were affected severely. He states also that it was quite abundant in the Puget Sound region of Washington. In general, however, the rust seemed to be of very minor importance in 1921.

A manuscript summarizing the knowledge concerning the occurrence of the disease in the United States is now in process of preparation by Dr. Humphrey and others.

Reference

Armstrong, S. F. The Mendelian inheritance of susceptibility and resistance to yellow rust in wheat. Jour. Agr. Sci. 12: 57-96. Feb. 1922.

Scab caused by Gibberella saubinetii (Mont.) Sacc.

Wheat scab (Fig. 43) apparently caused even less damage in most states in 1921 than it did in 1920, and certainly a great deal less than in 1919. The

disease was not found at all in the New England states nor in the Gulf states. Neither was it found in Texas, Oklahoma, Montana, Idaho, Washington, or Arizona. Only a single diseased specimen, according to Learn, was found in Colorado. Reports of collaborators indicate that the disease was unimportant in all states except those which are listed with percentage reduction in yield as follows: Ohio 7%, Illinois 4%, Missouri (considerable), Maryland 2%, West Virginia 2%, and North Dakota 5%. The only appreciable damage occurred in part of the soft red wheat region. The figures on losses refer almost entirely to head blight. Very little differentiation is made in collaborators' reports between the seedling blight caused by the scab organism, and seedling blights caused by other fungi. Consequently, accurate estimates of losses due to the seedling blight caused by the scab organism are not possible.

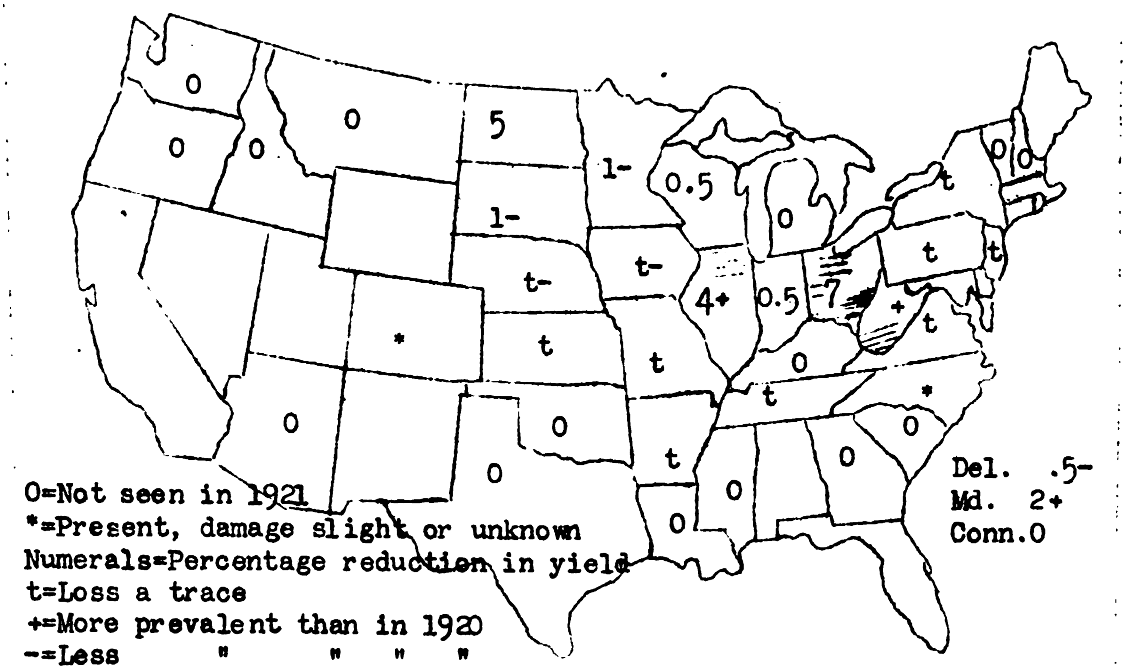


Fig. 43. Estimated percentage loss from wheat scab in 1921.

Relation of weather conditions to the development of scab

Weather conditions, as a rule, were unfavorable for the development of scab. Comments on this point are made by collaborators in Indiana, Kentucky, Tennessee, Virginia, South Dakota, and Minnesota. In all of these states the weather was rather hot and dry during the flowering period of the wheat. Consequently, very little infection occurred. In Ohio, however, and in some of the other states in the Ohio River Valley, weather conditions were very favorable for the development of scab in some localities and special attention is called by collaborators to the local occurrence of the disease. In most cases this can be correlated with the weather conditions at flowering time. In some states, in which both winter and spring wheats are grown, spring wheat was more severely injured than winter wheat. Both in New York and Illinois, Marquis wheat was much more severely injured by scab than were the winter varieties which are commonly grown.

The following comments made by collaborators in the various states give a fairly good idea of the scab situation in 1921:

New York: Fusarium scab seemed to be negligible factor in winter wheat as never more than a few infected heads were found in a single field. In spring wheat, where the growing region is farther north and Marquis is the principal variety, scab was found to be quite common. Scab was present to the extent of 5% in 175 acres of the fields of the biggest spring wheat seed salesman of the state. (Kirby, August 22).

Slight except for spring wheat which was reduced 5%. Damage largely in northern part of state. (Kirby).

Virginia: Occurred only in very slight amounts this year. There were practically no rains during blooming period. (Fromme).

Kentucky: Dry hot weather set in shortly before flowering period. No scab observed. (Valleau).

Tennessee: (Observations made during April, May, and June in the vicinity of Knoxville, Murfreesboro, Columbia, Nashville, Jackson, and Union City.) Wheat scab infection was extremely slight; in most of the fields only occasional specimens, and then not very conspicuous, could be found. No field was observed that was affected with the disease to any serious extent. Extremely dry weather during the time of blooming and during maturity of the wheat is the probable explanation of the low infection with the scab. (Sherbakoff).

Louisiana: Have never seen it in state. (Edgerton).

Arkansas: Scab has never been of importance here. (Elliott).

Ohio: The counties of Coshocton, Muskingum, Ross, Pickaway, Darke, and Van Wert were visited.

I was somewhat surprised to find disease conditions so serious in Ross County. Wheat fields in the overflow lands of the valleys were all badly infected with wheat scab. In some cases infection was 15%. It was interesting also to note that in general throughout Ross County the rotation corn, wheat and clover was quite universally followed.

The same general situation prevailed in southern Pickaway, such as I had opportunity to investigate.

Farther north in Van Wert County scab is very much less noticeable.

I am quite positive that wherever I investigated fields where a longer rotation is employed,- namely, corn, oats, wheat, and clover, or corn, oats, tobacco, wheat, and clover, also where some other legume such as alfalfa, soybeans, or sweet clover is introduced into the rotation - scab infections were very much lower. I was especially interested in the rotation investigations, not only as regards scab of wheat, but also in connection with the clover root rot disease which we have at the present time under investigation. (R. C. Thomas, June 27).

During the forepart of the season scab was very little in evidence. About June 15 this trouble became epidemic in Ohio, however, and since then has caused heavy loss with certain varieties. Of the pedigreed wheats, counts in many fields have shown that the Portage is very subject to scab attack while Gladden and Trumbull are not.

In one case where three varieties were planted side by side in the same field the counts were:

Portage	12% scab
Ohio Pride	2% scab
Trumbull	1% scab

Fields of Portage with as many as 50% of the heads affected by scab have been reported, while the average for the state has been around 10%. Gladden under the same conditions has shown about 1.5 to 2% scab, and Trumbull about 1%. (Clayton).

Scab developed late and caused severe loss with only one variety so far as I have observed. The Portage wheat, an improved variety, distributed by the Experiment Station was very badly affected and fields of Portage with as high as 50% of the heads affected have been reported.

Most varieties showed 1 to 3% of the heads attacked by scab. (Clayton).

More than usual, and more than last year, with a reduction in yield for the state of 5 to 10%. The infection was general but was worst in southern part of state. Greatest injury occurred after blossoming period, when weather was favorable for the disease. (Thomas).

Indiana: Very much less than usual; probably same as in 1920. Attributed to weather conditions unfavorable to infection. Less than 1% loss. (Gardner).

Illinois: In northern Illinois scab on spring wheat was very severe; running as high as 30% on the average. In central Illinois it was as bad as 12%. Little or no spring wheat is grown in southern Illinois. (Percentage based on number of heads infected. (Dungan).

Wisconsin: For the state as a whole infection was generally light but in spots in the southern part of the state, where more rain occurred and where wheat followed corn, there was some damage. (A. G. Johnson).

North Dakota: Naturally, scab in wheat, wilt in flax, ergot and similar wind-born troubles are more destructive in the counties of intense cultivation and particularly in the eastern part of the state where the soil and moisture conditions are more favorable. (Bolley).

Varietal resistance

Since it is difficult to control scab by ordinary means, varietal resistance is extremely important. There are very sharp differences in the susceptibility of the different varieties to the scab. In the hard red spring wheat region, for instance, the durums as a class and Marquis are extremely

susceptible, while Preston, Haynes bluestem, and several other varieties are much more resistant. Results of preliminary varietal tests at University Farm, St. Paul, Minnesota, have been furnished by Mr. J. J. Christensen, of the University of Minnesota (Table 29).

Table 29. Varietal susceptibility of wheat varieties to scab in 1921 in Minnesota, according to data furnished by J. J. Christensen.

Variety	Percent heads blighted		Percent of seeds of infected heads blighted	
	A	B	A	B
Preston, Minn. 924	0	.5	0	3
Haynes Bluestem, Minn. 163	1.5	.5	9	4
Glydon Fife, Minn. 163	1.5	0	11	0
Kota C. I. 5878	1.5	3	8	9.8
Kitchener C. I. 2153	2.5	1.5	10.3	10.5
Ruby C. I. 2151	2.5	3	28	18
Prelude C. I. 4323	2.9	3.9	8.1	15
Red Bobs C. I. 6255	2.5	8.3	11	23
Red Durum C. I. 1446	3	11	12	12.1
Marquis C. I. 1239	4.5	9.5	19	18
Acme C. I. 1967	6.5	8.5	19	12.3
Kubanka C. I. 2102	8.8	7.9	27.7	10
Monad C. I. 2156	12	10	18	14.5
Mindun, Minn. 470	14.5	9	14.1	16.6
Kubanka C. I. 2094	19.5	14	13	18.8
Kubanka (8) C. I. 4063		25.4		11.4

1. (A) planted April 23
2. (B) " May 10

Recent literature

Johnson, A. G. and J. G. Dickson. Wheat scab and its control. U. S. Dept. Agr. Farmers' Bul. 1224: 1-16. Illus. 1921.

Rose, Jessie P. A seedling blight caused by _Fusarium culmorum_ var. _leteius_ Sher. (Abstract). Phytopath. 12: 28. Jan. 1922.

Sherbakoff, C. D. Fusaria of wheat and corn. (Abstract). Phytopath. 12: 45. Jan. 1922.

Take-all caused by _Ophiobolus cariceti_ (Berk. & Br.) Sacc. (=_Ophiobolus graminis_ Sacc.)

Take-all caused by Ophiobolus was reported for the first time in the United States by Kirby and Thomas in October 1920. Since that time it has been found also in Indiana, Arkansas, and Oregon. The following extracts from the summary of the survey for take-all and flag smut in 1921, prepared by R. J. Haskell, gives the available information regarding the occurrence of the disease:

"1. Take-all associated with Ophiobolus.

As a result of this season's work Ophiobolus has been found associated with foot rots in three new states. It was found again in New York, this year in great abundance, and

in addition was discovered in Arkansas, Indiana, and Oregon.

"The New York situation is a rather serious one. Take-all has been found scattered through the major part of the western grain belt. It is present in at least nine of the sixteen counties surveyed and in many localities in considerable quantities. The disease is readily distinguished by the blackened bases of the culms accompanied by the mycelial plate and perithecia in most cases. It must have been present in the state for some years to have spread over so wide a territory.

"In Arkansas a disease having the same appearance as that in New York was found in two fields near Fayetteville by H. R. Rosen and in both fields an Ophiobolus was found on the diseased culms. In the first field the disease was generally prevalent throughout the whole eleven acres but was worse in spots; and in the second field, it was general but spotted in only three of the eleven acres, the three acres having been in peach orchard the year before.

"In Indiana, H. S. Jackson received specimens from Knox County having signs of take-all and an inspection of the locality showed three infested fields on a farm ten miles east of Vincennes. The disease was in spots of two to three feet in diameter. Immature Ophiobolus perithecia were found on the culms and from Jackson's description it appears to be like the New York disease.

"In Oregon, H. P. Barss found Ophiobolus near Hillsboro and in a number of other localities. At Hillsboro the loss in some cases is estimated at one-third the crop, the spots ranging up to 100 feet in diameter.

"2. Ophiobolus on wild grasses.

"Agropyron repens was found infected with Ophiobolus by R. S. Kirby in Genesee County, New York on June 10 and in the greenhouse Mr. Kirby appears to be getting infection on certain species of the genera Bromus, Agropyron, Elymus, and Hordeum. Johnson, Rosen, and McKinney collected Festuca, Bromus, and Hordeum in one of the infested fields in Arkansas on June 11 that seemed to be affected with the same disease as the wheat, and on June 23 Rosen reported he found perithecia, asci, and ascospores of Ophiobolus on Setaria geniculata growing on the campus at Fayetteville.

"Evidence pointing to the importance of grasses as hosts for Ophiobolus was found in the field in Arkansas where the disease occurred only in the three acres that had been in peach orchard in 1920. In the other Arkansas case the field had been in pasture for 12-14 years and the same seed planted on another part of the farm showed no disease.

"The occurrence of Ophiobolus on wild grasses will prevent control of take-all by rotation and will make the disease that much more difficult to combat."

Ophiobolus has apparently kept on doing considerable damage. Kirby reports that it is one of the most important cereal diseases in New York. It

kills the plants prematurely, and infected plants are not likely to produce more than 1% of a normal crop. The reduction in yield for the state of New York is estimated at approximately 1%. Barss reports as follows regarding the situation in Oregon:

> "Wheat specimens received from E. B. Dunsmore, Mosier, Oregon, looked like typical Ophiobolus. Fifty acres affected. Ten acres entirely killed out. Twenty-six acres hardly worth harvesting. The ten-acre tract went forty tons wheat hay two years ago."

Less is known about the destructiveness of the disease in other regions. The map of New York and the map of Oregon (Figs. 44 and 45) show how widely distributed the disease is in those states. The pathogene occurs on various other hosts besides wheat. It is especially important to note that it has been found in nature on several grasses. Kirby found *Agropyron repens* infected in New York, and in Arkansas Rosen found the organism on *Setaria geniculata*, and also on a grass which appeared to be *Hordeum pusillum*. Kirby (1) states that he has been able to infect wheat, barley, rye, and one or more species of the following genera of wild grasses: Agropyron, Bromus, Elymus, Festuca, Hordeum, Hystrix, Lolium, and Phalaris. He says also that in New York Number 6 Junior wheat appeared to be slightly more susceptible than Dawson Golden Chaff and Red Rock. In Oregon, according to Barss, Forty-fold, Dawson Golden Chaff, and White Winter varieties were most severely affected, while Rink and Jenkins' Club were only slightly attacked. It is quite possible, therefore, that the disease may be controlled by the use of resistant varieties. A general summary of what is known about the disease in New York has been made by Kirby.

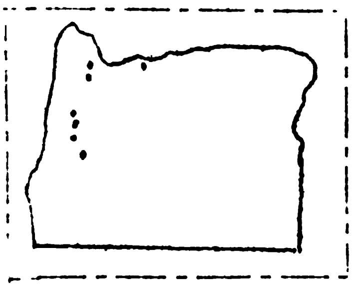


Fig. 45. Occurrence of wheat take-all in Oregon in 1921. (After map by H. P. Barss.)

Recent literature

Cited:

Kirby, R. S. The take-all disease of cereals and grasses. (Abstract). Phytopath. 12: 27. Jan. 1922.

Not cited:

Fitzpatrick, H. M., H. E. Thomas, and R. S. Kirby. *Ophiobolus cariceti* (Berk. & Br.) Sacc., cause take-all of wheat. (Abstract). Phytopath. 12: 27. Jan. 1922.

Fitzpatrick, H. M., H. E. Thomas, and R. S. Kirby. The Ophiobolus causing take-all of wheat. Mycologia 14: 30-37. Jan. 1922.

Foot and root rots of wheat

Several destructive foot and root rots of wheat have been reported during the past year. The etiology of some of these is not yet definitely determined, but they can be grouped for convenience under several heads: (1) rosette (so-called take-all), which has been under observation since 1919 in Illinois,

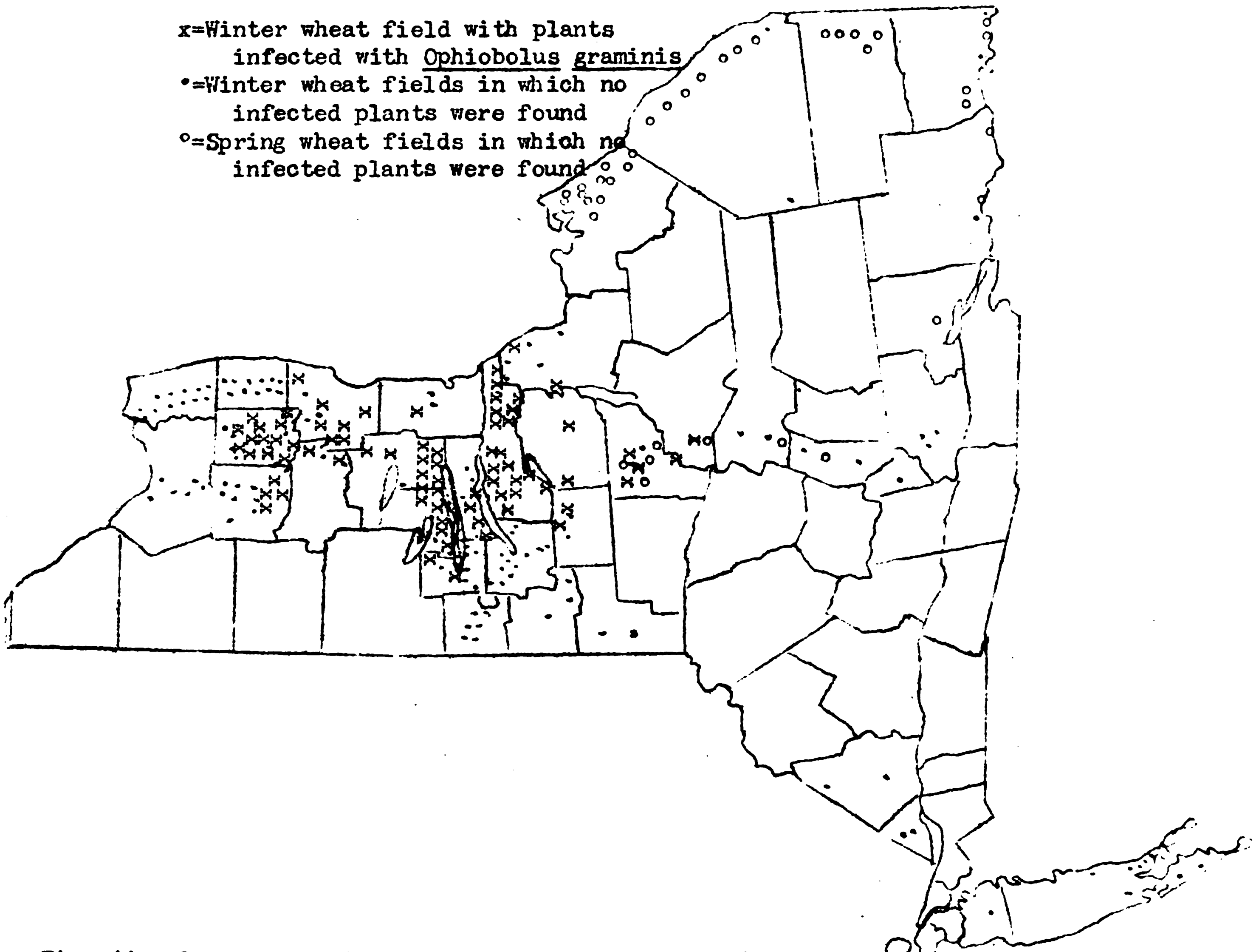


Fig. 44. Occurrence of take-all in New York, 1921 (after map prepared by R. S. Kirby). The disease is also known to occur in Indiana, Arkansas, and Oregon.

and which occurs also in Indiana; (2) the foot and root rot of wheat, barley, rye, and various grasses which is caused by Helminthosporium sativum and possibly other species of the genus. (For symptoms see Minn. Agr. Expt. Sta. Bul. 191); (3) foot rots of unknown causation, but with definite and characteristic symptoms; (4) foot and root rots of unknown causation and with indefinite symptoms.

Rosette, probably caused by Helminthosporium sp.

Rosette (so-called take-all) which was discovered in Illinois in 1919 is now well under control. The disease caused less damage in 1920 than it did in 1919 and in 1921 it caused still less damage. This probably is due to the fact that resistant varieties now are being grown in the infested regions. Dungan reports that there was only a trace of the disease in Madison and Logan Counties, Illinois, while the following excerpt from the report of Mr. J. R. Kendrick on conditions in Indiana, summarizes the situation in that state:

> "On June 17, a trip was made through the take-all quarantined area in northern Indiana, to examine spring wheat, winter wheat, and to look up a reported root rot of rye.
>
> "Sixty acres of spring wheat were examined, and no evidence of any root rot or take-all was found. The wheat is in good condition and is apparently better than the winter wheat. I believe the 60 acres comprise all the spring wheat in the quarantined region. The serious damage done by the Hessian fly in 1920 and the past scare due to the outbreak of take-all have made the farmers hesitate about sowing much wheat. They seeded a large acreage of rye last fall.
>
> "Something like 150 acres of winter wheat were examined and no evidence indicating take-all was present could be found."

There are very sharp differences in varietal susceptibility to the rosette disease. The following summary, prepared by H. H. McKinney, is taken from the Cereal Courier 13: 186-188. August 31, 1921:

> "During the present crop season 150 varieties and selections of wheat were grown on infested land to determine relative susceptibility to the so-called take-all disease. These experiments were conducted near Granite City, Ill., by the Office of Cereal Investigations, United States Department of Agriculture, in cooperation with the Illinois Agricultural Experiment Station. The susceptible varieties are shown in Table 30, and the more commonly grown ones that showed marked resistance are listed in the paragraph which follows. None of the latter showed any infection with the so-called take-all. These results, in general, agree with those obtained in 1920, particularly in that Harvest Queen (the white-chaffed Red Cross, locally known as Salzer's Prizetaker) was found to be highly susceptible,

and Red Wave, Early May, and a strain of Turkey highly resistant. Illini Chief was considerably more heavily infected in 1920 than in 1921."

Table 30. Percentage of disease on susceptible winter wheat varieties grown in infested soil to determine relative susceptibility to rosette at Granite City, Ill., 1921.

Variety	Seed Source	Percentage of Disease
Harvest Queen (Red Cross (white chaffed), Salzer's Prizetaker)	Illinois Station	95
Selection No. 13462 (bearded, red-chaffed)	C. I. No. 4834	95
Harvest Queen	C. I. No. 4882	75
Niagara (Sel. No. 13535)	C. I. No. 5307	70
Velvet Chaff (Penquite)	C. I. No. 3540	65
Missouri Bluestem	C. I. No. 1912	60
Dawson (Dawson's Golden Chaff)	Ill. 9-225	1-
" " " "	C. I. No. 6161	1-
Illini Chief	Illinois Station	1-
" "	C. I. No. 5406	Trace
Budapest	C. I. No. 5789	"
Turkey (Wis. No. 18)	Illinois Station	"
World's Champion	" "	"

The following varieties from the sources indicated showed no infection:

Beloglina, Illinois Station and C. I. No. 5964
Crimean, C. I. No. 5831
Currell, C. I. Nos. 2906, 3326, 4802
Dietz Longberry, C. I. Nos. 1981 and 3387
Early May (local)
Fulcaster, C. I. Nos. 3013, 3407, 4862
Fultz, C. I. Nos. 1923, 3349, 3423, 3594, 3598
Gypsy, Illinois Station and Nos. 3439 and 3440
Gladden, Illinois Station and 5644
Gold Coin (Junior No. 6), C. I.
Grandprize, C. I. No. 5627
Harvest Queen (White-chaffed Red Cross, Salzer's Prizetaker), Resistant selection
Harvest King, C. I. No. 5647
Hungarian, Illinois Station
Indiana Swamp, Illinois Station
Jones Fife, C. I. Nos. 1942 and 5608
Kanred, Illinois Station and C. I. No. 5146
Kharkof, C. I. No. 5661
Leap, C. I. No. 5618
Malakof, C. I. No. 5663 and Illinois Station No. 5-460
Mammoth Red, C. I. No. 2008

Mediterranean, C. I. No. 3467 and Illinois Station
Michigan Amber, C. I. No. 4864
Minnesota Reliable, Illinois Station
Nigger, C. I. No. 5652
Pesterboden, Illinois Station
Poole, C. I. No. 5653
Portage, C. I. No. 5370
Pride of Indiana, C. I. No. 3492
Red Cross (red-chaffed), C. I. No. 5318
Red Rock, Illinois Station
Red Wave, C. I. No. 5624 and Illinois Station
Reliable, C. I. No. 3508
Rudy, C. I. No. 5625
Stoner (Marvelous), C. I. Nos. 2980 and 5961
Super (Burbank's), C. I. No. 5544
Trumbull, C. I. No. 5657
Turkey, Illinois Station, Nos. -514, 10-110, 12-41, and 509, and C. I. No. 6152
Turkey (Wis. Ped. No. 2), Illinois Station
Turkey (Iowa No. 404), C. I. No. 5580
Wheedling, C. I. No. 4846

Judging from the work done by Stevens during the past three years, the rosette in Illinois is caused by a species of Helminthosporium. The following paper by McKinney is also interesting in this connection (McKinney, H. H. The Helminthosporium disease of wheat and the influence of soil temperature on seedling infection. (Abstract). Phytopath. 12. Jan. 1922.):

The rosette or Helminthosporium foot rot was observed in experimental fields in Illinois and Indiana and also in a field of Red Cross wheat near Lincoln, Logan County, Illinois. According to various collaborators, control measures, especially the use of resistant varieties, are responsible for the reduction in the prevalence and destructiveness of the disease.

Foot and root rots caused by Helminthosporium

Foot and root rots caused by Helminthosporium apparently occur quite commonly in various parts of the United States, and may possibly be etiologically the same. In fact, it is quite likely that the distribution is much more general than is indicated from reports. The damage caused by Helminthosporium and various other fungi is sometimes obscure and escapes attention. Bolley first called attention to this type of disease about 1909, and since that time considerable progress has been made in determining more definitely the etiology of this class of diseases. Just which species of Helminthosporium are responsible for the root rots is still an open question, although it is certain from work which has been done at various experiment stations and in the United States Department of Agriculture that H. sativum is capable of causing serious losses. The work of Louise J. Stakman, J. J. Christensen and Louise Dosdall in Minnesota indicates very clearly that the worst type of foot rot which occurs in that state, and which sometimes severely injures wheat, barley and rye, is caused by Helminthosporium sativum. The same disease is known to occur in other states in the hard red spring wheat area and undoubtedly it is destructive also in the several winter wheat sections. Collaborators have not assigned as a cause of the foot rot any particular species of Helmin-

thosporium in most cases, but it is quite likely that Helminthosporium sativum is one of those primarily responsible. This Helminthosporium type of root rot has been reported this year from Minnesota, North Dakota, South Dakota, New York, Kansas, and Idaho. It should be noted that according to Melchers two types of foot rot probably occur in Kansas, only one of which is caused by Helminthosporium. The following comments are illuminating:

New York: (Helminthosporium root rot (apparently *H. sativum*).) This type of injury was very common on winter wheat but on account of the fact that careful counts were not made of the amount of the infection, it would be impossible to say more than that the disease was fairly common on wheat in New York and that it likely caused more loss than was accredited to it. (R. S. Kirby, Aug. 22).

Kentucky: On May 13 and 14 I made an inspection trip through Logan and Christian Counties where there have been reports of considerable trouble in wheat. I was unable to find any signs of the flag smut or take-all, but there was considerable evidence of severe root rot in practically every field that we examined. In the worst fields it appeared to be the cause of severe stunting of certain plants, these plants never attaining a height of more than 3 or 4 inches when they died at about blossoming time. Other plants did not stool out, and sent up only a single short stalk which produced a small, short head; others stooled out and in many cases most of the shoots died when about 4 to 8 inches high. The remainder, however, fruited normally. We have found the same conditions to exist in most of the fields examined about Lexington. The cause of the root trouble I have not definitely determined, but from some work done the past winter on root diseases of wheat, in which about 60 varieties were worked with, I found rather a high percentage of seed infection with Helminthosporium and also some wheat scab infection. There was a marked contrast between fields planted from the ordinary varieties and from pure line selections. Where Ashland was used, the stand, by actual counts made by Mr. Kenney, was 25% better than the stand of Currell's Prolific which is a mixture of strains. This increased stand was due primarily to a greater uniformity in the number of culms produced, practically none of the severely stunted plants being found. It appears from our work so far that this root trouble may be handled to quite an extent by selecting resistant strains and eliminating the low yielding very susceptible strains from our varieties. I feel fairly confident that the percentage of seed infection with pathogenic organisms capable of causing root rot is sufficiently high so that practically complete root infection will take place in the field very soon after the seed is sown. (Valleau).

Oklahoma: (Referring to specimens sent by Robert Stratton.) I find No. 6 (wheat from Beaver County) to be wheat apparently affected with a species of Helminthosporium, known to be more or less common as a cause of foot rot in certain sections of the country. (H.B.Humphrey).

Illinois: Traces in Madison and Logan Counties. (Dungan).

Minnesota: A serious root and foot rot of rye, barley, and wheat was found in every county visited. The disease was most serious in the following counties: Wilkin, Marshall, Pennington, and Kittson. It was quite severe in localized areas of Anoka, Ramsey, and St. Louis Counties. Roots and bases of culms of infected plants were plated out on nutrient media. In nearly every case a species of Helminthosporium was isolated. Fusarium was seldom present in the cultures, although it often appeared to be present on the dead leaves and bases of culms, and it was apparently secondary in most cases.

The disease appears to be most severe on light soil such as peat and sand. This was apparent from the observations made in Marshall, Kittson, Pennington, St. Louis, and Anoka Counties. The disease was also observed to be extremely severe on heavy soil. One of the most severe infections was found at Fens, a peat experiment station near Duluth. Several plots of wheat and barley, including several varieties of each, were almost completely destroyed.

I did not see a single field of wheat or barley free from foot and root rot caused by Helminthosporium sp. I saw heavily infected fields, both of wheat and barley, following potatoes and other cultivated crops, but as a rule the disease showed up most where wheat, rye, and barley were grown continuously or where poor cultural methods were practiced. Weather, poor soil, cultural methods which tend to hinder normal growth of the plants, all favor the development of the fungus. Helminthosporium sativum has been shown to be one of the commonest causes of the disease in Minnesota. (J. J. Christensen).

North Dakota: This disease in wheat, each year, is becoming more and more destructive, acting as a seedling root blight. It has this year very materially aided the drought and hot weather to reduce the crop, not only in the Red River Valley, but in the western portions of the state. It has been particularly destructive on certain of the rust resistant durums such as Monad and Pentad. (Bolley).

South Dakota: I have just heard from Mr. McKinney on the wheat which I sent from the field near Aberdeen which gave indications of being take-all. He informs me that he has isolated Helminthosporium from it. I have had Professor Hutton test the soil where this wheat was growing and he informs me that there is about 1.25% alkali which is enough to cause serious damage to the crop. (Arthur T. Evans, July 2).

Kansas: We have isolated at least two species of Helminthosporium which have come out in practically every specimen that we have cultured. While Dr. McKinney and I have not compared our cultures microscopically we have compared them from the Petri dishes and apparently have gotten the same organism.

As the matter now stands, it seems as though we have two distinct problems in the state. The one in Dickinson County where the wheat is dying out in spots, has also been found at our

agronomy farm here in Riley County. Probably the same trouble exists in Cheyenne and Ellis Counties. From the majority of fields which have been reported injured and where Mr. Pearson has made examinations, we find another trouble which no doubt is the most common in the state this year. Plants are dying more or less all over the field. I attribute this injury to a number of factors in combination with one another.

The late freezes caused a great deal of refuse to accumulate on the ground and chiefly around the crown of the plants. In many places there was a considerable lack of rain. The soil also has been seriously depleted in many of these fields. Placing the plants under these conditions, together with excessive tillering, has produced a strain on the root system which it cannot meet. I believe that a great deal of this refuse material is a harboring place for semi-saprophytic and partially parasitic organisms which together with the organisms in the soil, have been responsible for a decay in the root system.

No doubt a number of imperfect fungi are entering into this problem. In most cases they are causing a distinct rotting of the roots under ground without very much discoloration on the lower internodes. This I believe is responsible for a great deal of our poor wheat this year. Under more or less normal conditions, this would not have been nearly so noticeable, but where wheat is grown year after year on this land, the conditions are favorable. (Melchers, June 6).

Idaho: Root rot, evidently due to Helminthosporium sp., is rather common around Rexburg in Upper Snake River Valley. Only wheat on dry land affected. Loss in regions affected may reach 4%. This season evidently favorable for the development of this trouble. Cold, wet spring followed by hot, dry weather. In winter wheat greatest injury where snow lay late in the spring. Same trouble later found near Paris in extreme southeastern Idaho. (Hungerford).

Literature

Hamblin, C. D. "Foot rot" of wheat caused by the fungus Helminthosporium. Agr. Gaz. N.S.W. 33: 13-19. Jan. 1922.

Other Foot and root rots

Undoubtedly, many other fungi under certain conditions also cause foot and root rots on wheat and other cereals. Mackie calls attention to the fact that Fusarium causes a serious root rot in California; and in Washington, Kansas, Kentucky, and Oklahoma there are rather destructive foot rots, the cause of which has not yet been ascertained. Stratton reports that in Oklahoma a disease, known as white heads, is present in nearly every field. The loss ranges from a trace to 20%, with an average of about 2%. He states that the disease is most destructive in fields in which continuous wheat culture is practiced, and that the diseased spots are where wheat has been pastured or where animals have stood. Melchers points out that there are two distinct types of foot rot in Kansas, one of which may be caused by Helminthosporium and the other of which resembles

take-all. This disease is described in a paper presented at the Toronto meetings by McKinney and Melchers. (McKinney, H. H. and L. E. Melchers. Foot-rot disease of wheat in Kansas. (Abstract). Phytopath. 12: 28-29. Jan. 1922.) A similar disease has been observed by Mackie and by Johnson in California.

One of the big problems confronting cereal pathologists is that of foot and root rots.

Nematode (Tylenchus tritici (Stein.) Bast.)

The nematode of wheat was reported from Virginia, West Virginia, North Carolina (first report in 1921), and Georgia. In Virginia the disease was slightly more prevalent than it was last year, and than it is in an average year. The loss for the entire state is estimated at .2%. According to Fromme, there were no severe attacks, but the disease occurred in small amounts in those sections in which it was previously known. In West Virginia, according to Giddings, the disease occurred only in the southeastern portion of the state, except for some local attacks in Mason County. The maximum percentage in any one field was 5, and the reduction in yield for the entire state, according to Giddings, was slight. In North Carolina, the nematode disease was reported for the first time, in Wilkes County. Foster states that the disease was prevalent in two sections where it probably caused a loss of from 10 to 20% of the crop. According to the farmers, it was rather common in the same sections last year, and some of them stated that they had seen the disease for the past five years. The disease occurs also in Jackson County, Georgia. This is the only county, McClintock says, in which it is known in that state. It was not as destructive in 1921 as in 1920 although it is said to be quite important in Jackson County. The accompanying map (Fig. 46) shows the present known distribution of wheat nematode.

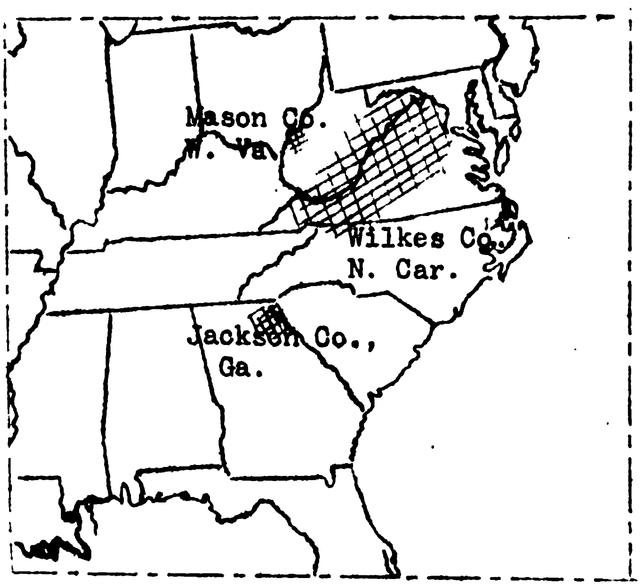


Fig. 46. Distribution of wheat nematode, Tylenchus tritici.

Black chaff caused by Bacterium translucens var. undulosum Smith, Jones & Reddy

Black chaff was reported as occurring only in Arkansas, Kansas, Colorado, Iowa, Nebraska, South Dakota, and Montana. It did no appreciable damage, accord-

ing to collaborators, except in Nebraska, in which the reduction in yield is estimated as a bare trace, and in Montana, in which Jennison estimates that the yield was reduced by 1.5%. The following comment by Jennison summarizes the situation in that state:

> "Very common throughout state and the cause of considerable shrinkage in late-planted fields. First significant outbreak since 1918. Appears to have been confined for most part to dry land spring wheat districts. Rapid spread during warm, moist spring. Hot dry weather in late July and August checked it. Found on Marquis and durum."

In Wisconsin the disease was found only in experimental plots of Kanred wheat, the seed of which had been grown in Kansas.

Anthracnose caused by Colletotrichum cereale Manns

Anthracnose occurred in the following states: New York, New Jersey, Pennsylvania, Maryland, Virginia, Tennessee, Arkansas, Ohio, Indiana, and Illinois. Miss Detmers states that in Ohio infection was generally present in fields in the central and southern parts of the state, particularly in fields severely attacked by leaf rust. The estimated reduction in yield for the state is 1%. In Illinois, the estimated reduction is .2%, and in the other states the disease did no appreciable damage for the state as a whole or it reduced the yield by only a bare trace. Fromme reports that anthracnose was severe in occasional fields in the south central part of Virginia. Apparently, however, the disease was unimportant except in Ohio.

Glume blotch caused by Septoria glumarum Pass.

Glume blotch of wheat was reported from the following states: New York, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, Arkansas, Ohio, Indiana, Illinois, Wisconsin, Iowa, Minnesota, and Nebraska. It apparently did not cause serious damage in any one of these states. The highest percentage of reduction in yield was reported from Arkansas, where Elliott estimated that the yield had been reduced by 1%. In practically all of the other states in which the disease occurred, it is reported merely as occurring, but not as being destructive except in some localities. However, it was important in certain places and under certain conditions. Possibly after more information has been obtained it may be shown to be more destructive than it is now supposed to be.

Fromme reports that the disease sometimes causes local damage in Virginia. He states that many plants are severely dwarfed and the heads are injured on account of infection of the rachis. The disease was epidemic in Pittsylvania County, but was relatively unimportant in other sections of the state. Rosen comments as follows on the situation in Arkansas and calls attention also to the destructiveness of the disease in Australia:

> "I am prepared to say that this is a rather serious thing with us, standing right next to leaf rust, Puccinia

triticina, in severity of attack. It seems to me that this is a disease of importance from a national standpoint, judging from the outbreaks in this state. Particular attention ought to be given in the states adjoining Arkansas, for I am under the impression that I saw this thing two years ago in Missouri, although I have no specimens and am not certain of this.

"I have just received a statement from Dr. W. B. Grove of England, in which he tells me that while the disease is not serious in England, it is as serious in Australia as it is in our state."

In Arkansas Technical Bulletin 175, May 1921, Rosen states that the correct name of the organism is Septoria nodorum Berk. The following names would be synonyms: Septoria glumarum Pass., (?) Septoria fusispora Died., Phoma Hennebergii Kuehn., Macrophoma Hennebergii (Kuehn) Berl. and Vogl., and (?) Ascochyta graminicola Sacc. in part. Rosen says that wheat in the vicinity of Fayetteville has been severely attacked for three successive seasons. The disease occurs on many varieties. It has been located in Independence County, as well as Washington County, which are widely separated; and probably occurs in other localities. According to Rosen, the disease has been reported from Maryland (Townsend 1898; severe injury), and Ohio (Selby, 1898), and perhaps also from Wisconsin (Davis) and Connecticut (Clinton, 1918). The use of early maturing varieties, proper crop rotation and clean seed should be successful in controlling the disease.

Another publication on this subject which will be interesting is that by Weber. (Weber, George F. Studies on Septoria diseases of cereals and certain grasses. (Abstract). Phytopath. 12: 44. Jan. 1922.)

Fromme gives the following observations on the percentage of severely infected heads of different varieties at the Chatham sub-station: Red May 95, Fulcaster 85, Fultz 70, Red Umber 65, Leap's Prolific 65, Stoner 25, Fulcaster Selection (seed treated by hot water method) 25.

Septoria leaf spot caused by Septoria graminum Desm.

Leaf spot caused by Septoria graminum was reported in 1921 from the following states: New York, Delaware, Maryland, Virginia, West Virginia, Kentucky, North Carolina, Arkansas, Ohio, Indiana, Illinois, Wisconsin, Minnesota, Missouri, Nebraska, Kansas, Idaho, Oregon, and California. Apparently it caused but little damage in most of them. The greatest reduction in yield was .5% in Maryland. In all of the other states it was reported that the disease either did no appreciable damage or only a trace. The following comments are interesting:

Virginia: Severe in Pittsylvania County, accompanying glume blotch. (Fromme).

Kentucky: Open warm winter and very warm period in March made weather conditions favorable, but the percentage in loss was none, or very slight. (Valleau).

Tennessee: (Observations made during April, May, and June in the vicinity

of Knoxville, Murfreesboro, Columbia, Nashville, Jackson, and Union City.) Leaf spot had been found early in April very common in most of the fields from Columbia to Union City. In several fields near Nashville the leaf spot was present to the extent of about 10% of the plants. However, in many fields only traces of it could be found. The damage caused was probably slight. (Sherbakoff).

Nebraska: Common in fall of 1920, uncommon in spring of 1921, on winter wheat. (Goss).

Oregon: Apparently confined to western Oregon from north to south, in region of mild, moist winter conditions. (Barss).

Recent literature

Weber, George F. Studies on Septoria diseases of cereals and certain grasses. (Abstract). Phytopath. 12: 44. Jan. 1922.

Ergot caused by *Claviceps purpurea* (Fr.) Tul.

Ergot of wheat was reported from Virginia, North Carolina, Illinois, Wisconsin, Minnesota, North Dakota, and Nebraska. In Virginia the loss was very slight, according to Fromme; in Illinois the loss was a trace only. and in Wisconsin the infection was said to be general but very light. The disease has been increasing in severity in the durum wheat regions of Minnesota and North Dakota (Fig. 47). Durum varieties seem to be especially susceptible. In the rust nursery at University Farm, St. Paul, Minnesota, some durum varieties are severely attacked and some of the durum common wheat hybrids also seem to be very susceptible. It is quite noticeable that during the past few years the increase in the severity of the disease has become an object of concern to growers and semolina manufacturers. It is said that the presence of more than 1/10 of 1% ergot in flour or semolina is dangerous. In many samples of durum, from the 1921 crop, the percentage of ergot bodies is as high as 2% or 3% and in some lots of wheat it is as much as 10%. In fact, in some of the durum-growing regions the flies which spread the conidia were so numerous as to lead the farmers to believe that the insects themselves were doing the damage. Bolley writes that ergot was epidemic in the region of North Dakota, northeast of Devil's Lake, and that entire fields were practically destroyed in that region.

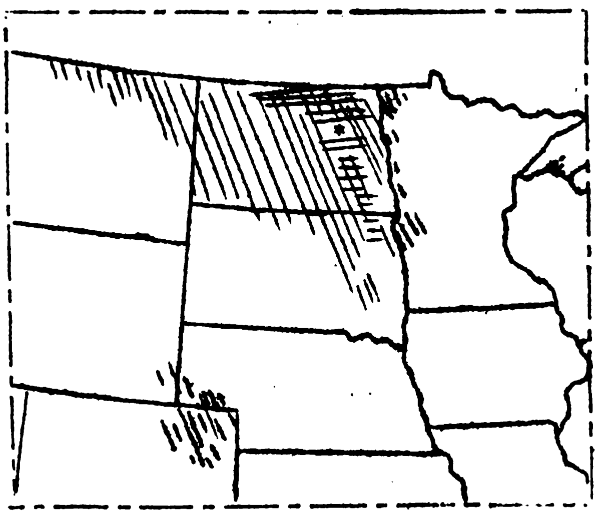


Fig. 47. Approximate intensity of production of durum wheat. Ergot worst in region with * as center. Durum wheat area and area of heavy ergot infestation practically coincide.

While ergot has not been so destructive in Minnesota durum fields as in those of North Dakota, still it has been present in appreciable amounts and in some samples of wheat there have been from 2 to 4% of ergot bodies. Unless natural conditions become unfavorable for the development of the disease it will become necessary to use control measures.

The following comment, taken from the New Macaroni Journal, Minneapolis, Minnesota, December 15, 1921, (Vol. III, No. 8, p. 20) gives an idea of the situation in the durum wheat growing sections of the northwest:

> "Samples submitted to the government officials from sections of North Dakota show as high as 10% of ergot after threshing. This does not fully represent the amount of ergot produced with the crop for an appreciable percentage of the sclerotia, as the small ergot bodies are known, would of course be blown out with the foreign materials as part of the screenings or the straw.
>
> "While this disease is not a new detriment to cereal culture, having been found in various sections of the grain country for many years, it is just the last few years that its effects have been felt. Investigations show that it is not only much more prevalent than ever before known but also that it is more widely distributed.
>
> "Durum wheats seem to be more subject to this disease than the ordinary bread wheats. This opinion is based on field observations and a study of samples of durum, which show a higher percentage of ergot in the durum varieties."

Powdery mildew caused by *Erysiphe graminis* DC.

Powdery mildew was observed in the following states: New York, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, Arkansas, Ohio, Wisconsin, Minnesota, Kansas, Washington, Oregon, and California. It was reported as present without doing any appreciable damage except in New York, Pennsylvania, and Virginia. In New York the damage was estimated by Kirby to be 1%, while in Pennsylvania, Virginia, and Oregon it was a trace. Fromme states that in Virginia the disease was occasionally severe. In Kentucky, Valleau found it particularly on young plants and on plants which had lodged. The following comments give some idea of the situation in several states:

New York: On account of the early warm spring this fungus attacked the wheat very severely and caused considerable damage which may have reached 1 or 1.5%. (Kirby).

Pennsylvania: Caused considerable alarm in the spring but dry weather checked it and it apparently did little harm. (Thurston and Orton).

Delaware: First observed April 8. Associated with considerable yellowing in fields but not seriously affecting growth. (Adams).

Montana: Some damage in irrigated sections where grain lodged. (H. E. Morris).

Oregon: The only serious damage in certain spring grain fields in the northern Willamette Valley. (Barss).

Downy mildew caused by *Sclerospora macrospora* Sacc.

Downy mildew of wheat, which had previously been unknown in the United States, was found during the past season in Jackson and Obion Counties, Tennessee, and in Fulton County, Kentucky. Herbarium specimens in the University of California show that the disease occurred in Kings County, California, in May 1919. W. H. Weston points out that the disease occurs mostly on low lying, poorly drained fields. The present known facts regarding the disease are summarized by Weston in Department Circular 186. (Weston, William H. The occurrence of wheat downy mildew in the United States. U. S. Dept. Agr. Circ. 186: 1-6. June 1921.)

Leaf spot associated with *Penicillium* sp.

A report of a leaf spot which was associated with a species of Penicillium was received from Forest Grove, Oregon May 27. On plants two or three inches high there were while withered spots on the leaf blades, which fell over. Only one field was affected. The weather had previously been cool and moist, and with the return of bright weather a week later the field recovered. The variety was Marquis, and had been seeded late.

RYE

Stem rust caused by *Puccinia graminis* Pers.

The stem rust of rye was relatively unimportant during the past year. The only states in which the yield was reduced appreciably were in Ohio, Michigan, and Minnesota. In each of these states the percentage of reduction in yield is estimated as 1%. White the rust was present in many other states as indicated on the map (Fig. 48) it was not important economically. This is very probably due to the fact that rye matures so early as to escape rust damage. In Michigan, according to Coons, there was decided local effect near barberries. Heavy infection occurred in some fields near rusted bushes. The same observations were made in Indiana, Illinois, and Minnesota.

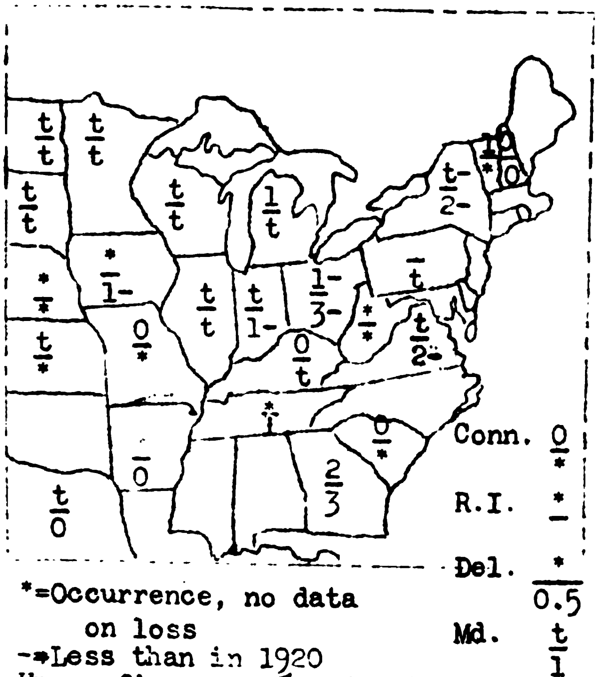
Rhode Island: Very common this year in uredo stage. Caused serious destruction of leaves. (Browning).

Michigan: Heavy rusting; loss probably not more than 5%. Epidemics near barberry locations in southwestern Michigan with no general infection in district. (Coons).

Indiana: Locally serious in vicinity of barberries. Noted in northeastern counties. (Jackson).

Minnesota: First reported about June 20 in Freeborn County. Fairly heavy on late rye. In some localities the yield probably was reduced by as much as 5%. (Department of Plant Pathology).

Nebraska: Stem rust was very general throughout the state on rye, but the infection was light. (Thiel, A. F. Cereal Courier 13: 141. July 20).



*=Occurrence, no data on loss
-*Less than in 1920
Upper figures = % reduction due to stem rust
Lower " " " " " leaf rust

Fig. 48. Estimated losses from stem rust (upper figures) and leaf rust (lower figures) of rye, 1921.

Leaf rust caused by *Puccinia dispersa* Eriks.

The leaf rust of rye apparently caused some reduction in yield in several states during the past season, although it was relatively uncommon. The distribution of the disease and the amount of damage done are indicated on the map given under stem rust (Fig. 48). The urediniospores of the leaf rust of rye overwinter commonly and readily so that there is almost always sufficient inoculum to cause fairly general rust attacks, even in the northern rye-growing states, such as Michigan, Wisconsin, Minnesota, and the Dakotas. However, the rust seldom does any real damage in the principal rye growing states on account of the early maturity of the crop. During the past year Clayton estimated that the yield was reduced in Ohio by 3%, McClintock estimated the same for Georgia, Kirby estimated 2% in New York, and Fromme, 2% in Virginia. Aside from these states, however, the damage was insignificant.

Recent work conducted by Mains throws new light on the life history of the leaf rust parasite.

> "Efforts to obtain an infection of the leaf rust on Anchusa indicate that there may be two races of the rye rust, one of which may parasitize some other heteroecious host than Anchusa. An effort to determine this host will be made." (Mains, E. B. Cereal Courier 13: 66. April 30, 1921.)

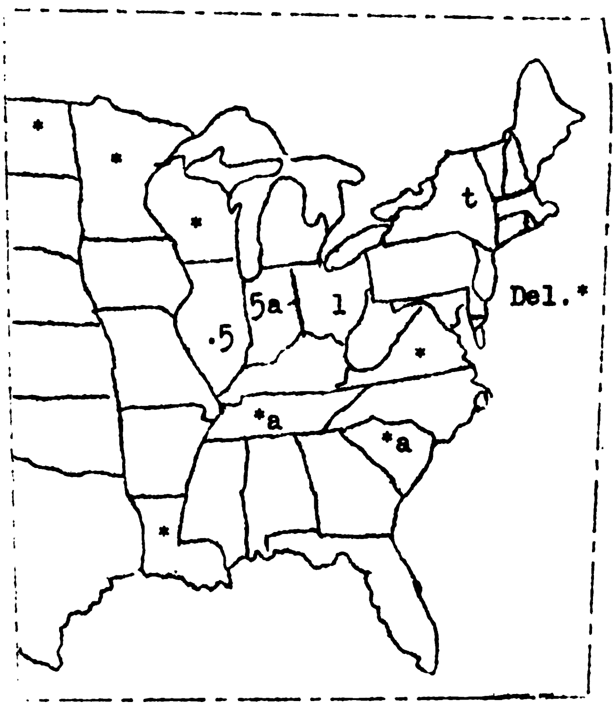
The possibility of developing rust resistant varieties of rye is suggested by Mains and Leighty (Mains, E. B., and C. E. Leighty. Rye resistant to leaf rust Puccinia dispersa (Abstract). Phytopath. 12: 33. Jan. 1922.)

Scab caused by Gibberella saubinetii (Mont.) Sacc.

The head blight, or scab, of rye was observed in 1921 in the following states: New York, Delaware, Virginia, Indiana, Illinois, Wisconsin, and Missouri. It apparently did not reduce the yield in any of them. In fact, in New York only a single scabbed head was found, and, while small amounts of the disease could be found in many places in several of the other states from which reports were received, the disease did not reduce the yield to any extent. While scab probably is more prevalent on rye than on any one of the other small grains except wheat, it apparently seldom does any appreciable damage unless by causing seedling blight. The head blight is seldom prevalent enough to be very destructive.

Anthracnose caused by Colletotrichum cereale Manns

The anthracnose of rye was reported from the following states: New York, Delaware, Virginia, Tennessee, South Carolina, Louisiana, Ohio, Maryland, Illinois, Wisconsin, Iowa, Minnesota, and North Dakota (Fig. 49). In most of the states the disease was not especially important. However, in some of them it did some damage locally. In Tennessee, according to Sherbakoff, Hesler, and Essary, the disease did considerable damage. In South Carolina, Ludwig states that the damage was serious locally, particularly in one locality in which the heads were severely injured. In Ohio, where culm infection was severe enough to cause considerable kernel shriveling, the reduction in yield is estimated at between .5% and 1%. In Indiana there was a great deal more of the disease than had ever been reported before. The following statement made by J. B. Kendrick summarizes the observations in Indiana:



*=Occurred, loss not known
(a)=See comments in text

Fig. 49. Percentage loss from rye anthracnose in 1921.

"A farmer, Mr. August H. Greiger, reported a serious trouble in his fifty-acre field of Rosen rye in Porter County. He reported a fungus or mould growing on the roots and the rye dying. On examination, I found the trouble to be anthracnose, and very serious. From 40-60% of the rye was dead, the trouble being rather

> uniformly distributed over the fields. The stalks were dead at the crown, and there was lots of infection on the heads. I examined 50 acres nearby, and found anthracnose present, but not as severe as on the farm of Mr. Greiger. There was 8-10% of the rye dead in these fields. The reports of the farmers visited were that the rye was generally affected by this trouble and it was causing them considerable worry for fear it was the same trouble they had in wheat in 1919. There is no doubt but that their trouble is anthracnose.

In Illinois also the disease was much more prevalent, according to Dungan and Tehon, than in 1920 although the reduction in yield for the entire state is estimated at .5%. In Wisconsin the disease was present in destructive amounts only in Forest County, while in Minnesota and North Dakota it was present but apparently did no appreciable damage. It is possible that the disease actually causes greater reduction in yields than is generally supposed. It is quite probable that some of the damage is overlooked, although in the principal rye-growing states it is quite likely the estimates are fairly accurate. Gardner suggests that in Indiana the reason for the heavy attack was the excessive rains during May and the first part of June.

Powdery mildew caused by _Erysiphe graminis_ DC.

Powdery mildew was observed in the following states: Delaware, Maryland, Virginia, Kentucky, Arkansas, Wisconsin, and California. It apparently did no appreciable damage in any of them except in Maryland, in which Temple and Jehle estimate that the yield was reduced by about 1%. While the disease occurs on rye under exceptional conditions in practically all of the rye-growing states, it is seldom prevalent enough to attract any particular attention and usually is of no economic importance.

Stem smut caused by _Urocystis occulta_ (Wallr.) Rab.

The stem smut of rye was observed in the following states: New York, New Hampshire, Virginia, West Virginia, Maryland, Michigan, Wisconsin, Iowa, and Minnesota. The highest percentages of infection recorded are between 2% and 3% in Indiana, although undoubtedly individual fields in some of the other states contained considerably more smut. The damage from stem smut of rye quite often is overlooked because it is rather difficult to detect after the plants have begun to ripen. The reduction in yield was 1.5% in Iowa, .5% in Minnesota, and all of the other states reported only a trace. The disease can be controlled rather readily by means of seed treatment and rotation. It is known that the spores will live in the soil from harvest time until sowing time in the same season. However, by the following year practically all of the spores have germinated and the danger of soil infection is thus eliminated.

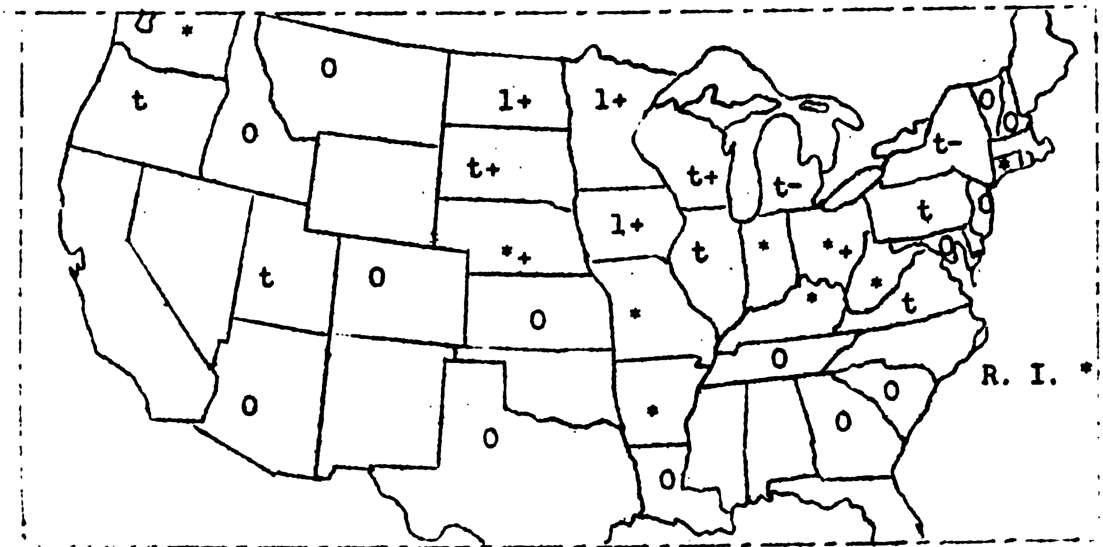
Head smut caused by _Ustilago_ sp.

Head smut of rye, the identity of which is still somewhat in doubt, was found in two states during the past year. In New York the disease was found on

volunteer rye in a wheat field near Ithaca, but was not observed elsewhere in the state. C. T. Gregory states that smutted heads were received also from Kosciusko County, Indiana.

Ergot caused by Claviceps purpurea (Fr.) Tul.

The distribution and losses caused by rye ergot are indicated on the accompanying map, Fig. 50. It will be noticed that the disease did very little



0=Not observed
*=Occurred but loss negligible
+=More than 1920
-=Less " "

Fig. 50. Occurrence of ergot of rye in 1921.

damage during the past year. The greatest reductions in yield are reported from Minnesota and North Dakota, in both of which the yield is estimated to have been reduced by 1%. In most of the other states the yield was not appreciably affected. Apparently the disease was more prevalent than in the previous year in Wisconsin, Minnesota, the two Dakotas and Ohio. In the other states it apparently was about the same as or even less injurious than in 1920. Evans states that in South Dakota there was a great deal of ergot on Dean rye but only a little on Swedish and Advance, the two best varieties in South Dakota.

Recent literature

Seymour, E. K. and F. T. McFarland. Loss from rye ergot. Phytopath. 11: 285-289. July 1921. (Nov.).

Take-all caused by Ophiobolus cariceti (Berk. & Br.) Sacc.

The true take-all of rye was reported from New York. Kirby states that it occurred in Monroe County only, and on only one plant.

Foot and root rots

Root rot in Indiana

Special note is made by collaborators of what appear to be three types of root rots. Jackson found what appears to be a new type of root rot of rye in Indiana. The following quotation is from a letter to Dr. G. R. Lyman regarding the root rot in Indiana.

> "I made a trip last week in Porter, LaPorte, and Starke Counties, and ran across a peculiar root rot of rye in Starke County. The plants were dying in large patches shortly after heading out. The plants had somewhat the appearance of those badly affected with anthracnose, but this fungus was not present. The roots, however, were rotted off, but without any evidence of fruiting bodies which could account for the trouble. Cultures have been made from these roots and the bases of the stalks. A fungus seems to be present, but I can not yet be sure whether we have the causal fungus. In fact, it would probably take some investigation to determine whether the fungi which we have isolated will cause a root rot in rye. The disease seems to be different from anything I have seen described on rye." (H. S. Jackson, June 27).

Foot and root rot caused by *Helminthosporium sativum* P. K. & B.

J. J. Christensen reports that a destructive foot and root rot caused by *Helminthosporium sativum* was fairly prevalent and destructive in some localities in Minnesota. The disease causes a stunting of the plants and blasting of the heads. This disease was quite destructive in Minnesota in 1919, apparently less destructive in 1920, but quite destructive again in 1921. It is estimated that the disease was found in at least 90% of the fields of the state.

White heads

Stratton reports that in Oklahoma white heads, such as is described for wheat, also occurs on rye (see wheat - miscellaneous foot rots).

Miscellaneous diseases

A disease similar to black chaff was found by Evans in South Dakota. He writes as follows:

> "I have found one new disease on rye, rather similar to black chaff on wheat, but the organism has not been identified or named as yet. It was only found in one field and then doing only a medium amount of damage."

Bacterial leaf spot. Hungerford found a bacterial leaf spot of rye in northern Idaho but no complete description is yet available.

Covered smut caused by _Ustilago hordei_ (Pers.) K. & S.

Covered smut of barley is found practically wherever barley is grown, although during the past year it apparently did not do very much damage. The greatest reduction in yield is reported from Tennessee (4%). In Kentucky, according to Valleau, the loss was about 3%; Fromme estimated that the yield

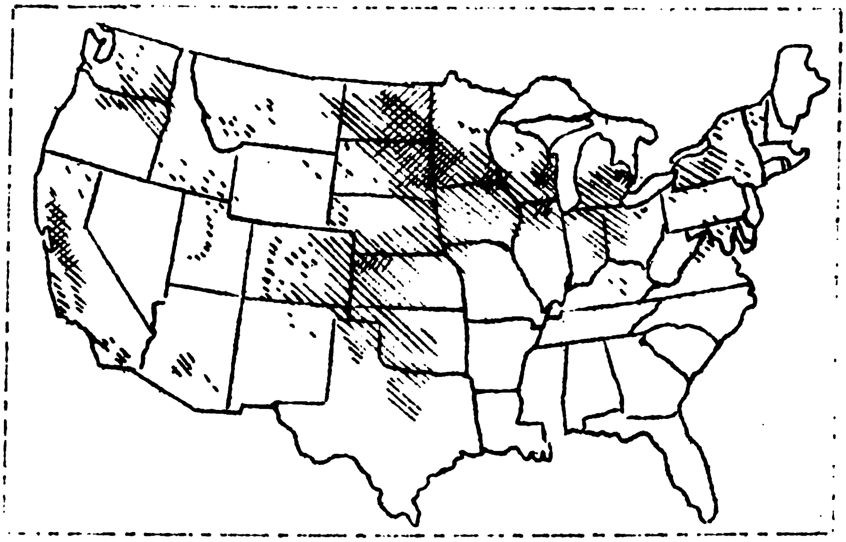


Fig. 51. Distribution of barley in the United States. (Map prepared in the Office of Farm Management.)

in Virginia was reduced 2%; and Taubenhaus estimated that the loss in Texas was about the same. The loss in Montana was also about 2%, according to Jennison. The disease did not cause more than 1% loss in any other state from which reports were received and in most of them the loss was only a trace, although the percentage of reduction in some individual fields was high. The loss in Arkansas was placed at 5% but practically no barley is grown in that state, according to Elliott. In Kansas, according to Melchers there was as much as 50% of smut in some fields, while in Missouri 30% of the heads in some fields were affected, and in Indiana the highest percentage of smut in any individual field was 15. In Coahuila, Mexico, according to Christopher and Stakman, smut was very general. The percentage of infected heads in various fields ranged from 5 to 20. For distribution and losses see the map, Fig. 52.

The disease is controlled easily by ordinary seed treatment, including the modified hot water treatment for loose smut. The results of experiments to determine varietal resistance apparently were disappointing. The following comment from the Cereal Courier summarizes the work done at Arlington Farm, Virginia in 1921:

> The experiments for testing the behavior of varieties of barley toward infection by the covered smut fungus were as usual unsuccessful. So far, practically all attempts at getting infection by smutting the seed at the time of sowing have met with little or no success. Some varieties show a slight increase in the percentage of infection when the seed is smutted, while others do not. Seed of most varieties

when taken from a smutty field produce some infected plants.

Smutted seed sown October 9 produced more smut than smutted seed sown October 30. However, very few varieties showed infection in either case and the percentages were low.

In the seed treatment plats hot water proved to be very effective in controlling both the smuts of barley. Formaldehyde was almost as effective as hot water in controlling the loose smut, but less effective against the covered smut. This is the reverse of what one might expect. It is more effective against covered smut in some varieties than in others. (W. H. Tisdale. Cereal Courier 13: 280-284. Dec. 30.)

Mackie comments as follows on the conditions in California:

"Hidden smut of barley is very rare in the state this year. In the Salinas Valley and in the coast counties of Southern California the attacks were the most severe amounting, however, to no more than 5% in the fields attacked." (July 1).

"Covered smut of barley is apparently affected by climatic and soil conditions to a marked extent. The low lying river or lake bottom lands usually show the most barley smut. The percentage of attack appears to be greater on wet years.

"Experiments in California have for three years failed in attempt to create heavy smut attacks by artificially inoculating barley seed. This has been the experience of other investigators. It has therefore been impossible to determine the smut resistance of any of the hundreds of barley varieties under test.

"While inspecting the barley being prepared for foreign shipments at Port Costa, it was noticed that the majority of the lots examined showed considerable smut. It is difficult to form an estimate of the losses from the appearance of smut in the sacked grain but undoubtedly it is very considerable." (August 1).

Loose smut caused by Ustilago nuda (Jens.) K. & S.

The loose smut of barley occurred in practically every state in which barley is grown. It was reported this year from the states which are indicated on the map, Fig. 52. The losses were not particularly serious in most states, although the losses were quite heavy in Pennsylvania (4-5%), Virginia (5%), Kentucky (6%), Tennessee (2%), Oklahoma (3%), Montana (2%), and Arkansas (15% - very little barley grown). In most of the other states the yield was reduced by 1% or less, although the percentage of infection in individual fields was sometimes fairly high; in Michigan, for instance, from 1 to 10% and in Montana as many as 15% of the plants were affected, while Evans states that in South Dakota 20% of the heads were smutted in some fields.

Apparently the hot water treatment is little used. In fact, the replies to a special questionnaire show very clearly that most of the collaborators

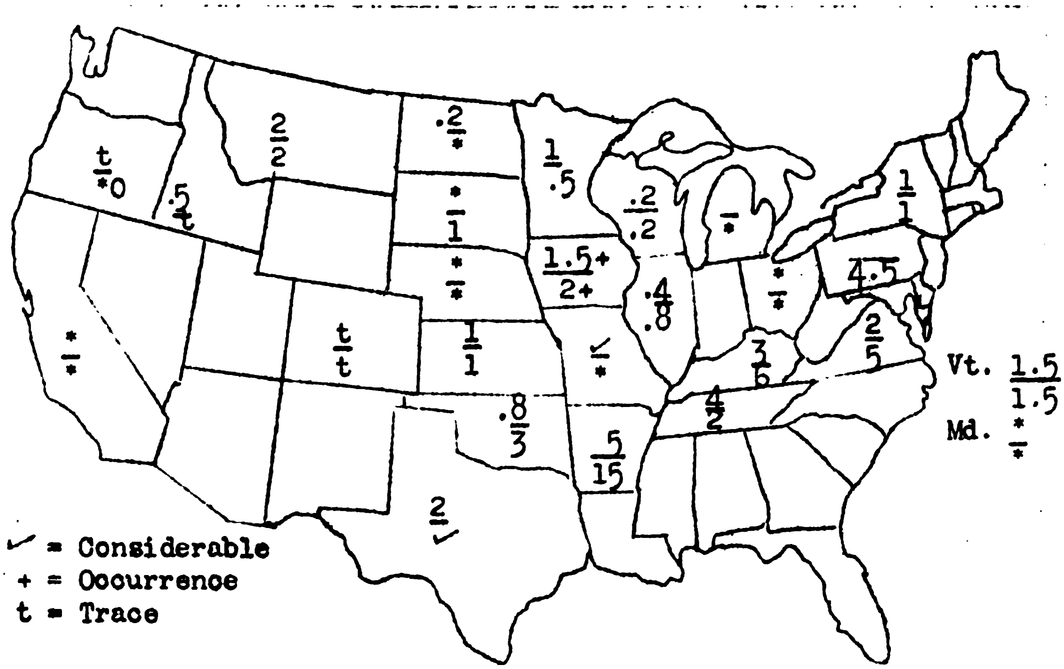


Fig. 52. Covered and loose smuts of barley. (Upper figures represent covered smut; lower figures, loose smut.)

consider that the loose smut of barley is of minor importance and that it is not sufficiently injurious to necessitate treatment. In a few states, however, central treating plants have been used. Giddings reports that in West Virginia the modified hot water treatment has been used to some extent in the eastern part of the state, but only in small areas and under the supervision of county agents and also of some representative from the experiment station. He states that in about 50% of the seed lots, germination was not affected while in the others the viability was somewhat reduced. In Virginia, according to Fromme, the hot water treatment was used on barley during the past year, and controlled almost entirely both the loose and the covered smuts. The treatment was carried out at central treating plants. The following comment by Taylor, concerning work conducted at the Arlington Farm, is interesting:

> The fortieth-acre plats of barley treated for smut by Dr. G. M. Reed show as conclusive results as last year. All varieties in the varietal experiments for the current year were treated by the hot water method and a general examination of these plats has shown but two smutted plants, both covered smut (*U. hordei*). The ten plats treated with formalin show occasional plants infected with covered smut. The ten untreated plats have a heavy infection of both loose and covered smuts. (Taylor, J. W. Cereal Courier 13: 70. May 10, 1921.)

Bolley suggests that the disease is at least partly amenable to the proper kind of formaldehyde treatment, and says that it is much reduced on all farms on which proper seed treatment is practiced persistently.

Stem rust caused by Puccinia graminis Pers.

Stem rust did not injure barley appreciably in most states during the past year. This probably is due to the fact that the host matures so early as to escape severe rust infection. However, the local loss was in some cases considerable. Kirby reports that infection was considerably heavier in New York on barley than on wheat, probably on account of the fact that the Puccinia graminis secalis strain of rust is more commonly distributed from the barberry. This probably is due to the prevalence of Agropyron repens, which is susceptible to the secalis strain but not to the tritici form. Tehon and Dungan state that in Illinois the stem rust of barley was present, especially near barberry plantings. Vaughan reports that the stem rust of barley was more prevalent in Wisconsin than usual and, while there was no rust on early plantings, the later plantings were rusted, although the loss was only a trace. In Minnesota also the infection was heavier than usual, and the yield probably was reduced by about 3%, although it was difficult to differentiate between heat injury and rust. In Iowa the reduction in yield is estimated at 7%, by Melhus, who says that there was very much less rust than during 1920. Bolley comments as follows on the occurrence of rust in North Dakota:

> "Stem rust of barley was not a factor of great importance to reduce the crop this year. Far more damage was done by the heat and drought which shortened the life of the crop and perhaps held the rust in control."

Thiel suggests that there undoubtedly was a reduction in yield in Nebraska on account of the heavy general infection. According to Mackie, the stem rust usually is not very injurious in California but it was more prevalent in 1921 than in previous years. He states that some entire fields were ruined. The only states from which percentages of the reduction in yield are available are Vermont (1%), Michigan (1%), Wisconsin (1%), Iowa (7%), Minnesota (3%), and South Dakota (2%). See map, Fig. 53, for distribution and losses.

Stripe rust caused by Puccinia glumarum Eriks. & Henn.

Report cards were received from Montana, Colorado, Idaho, Washington, and Oregon, but in no one of these states was the yellow stripe rust reported on barley during the past season.

Leaf rust caused by Puccinia simplex (Koern.) Eriks. & Henn.

The known distribution of Puccinia simplex in the United States is indicated on the accompanying map, Fig. 53. The rust was observed during the past season in Vermont, New York, Texas, Illinois, Iowa, South Dakota, Nebraska, Kansas, Montana, Colorado, Oregon, and California. It apparently did no real damage in any of these states. Mackie reports that it was present in California, particularly in the Sacramento Valley, and in the coastal regions where it appeared during May but that it seemed unimportant. It seldom has been severe enough to attract much attention except in California. A small amount was found in May in the state of Coahuila, Mexico by Stakman and Christopher.

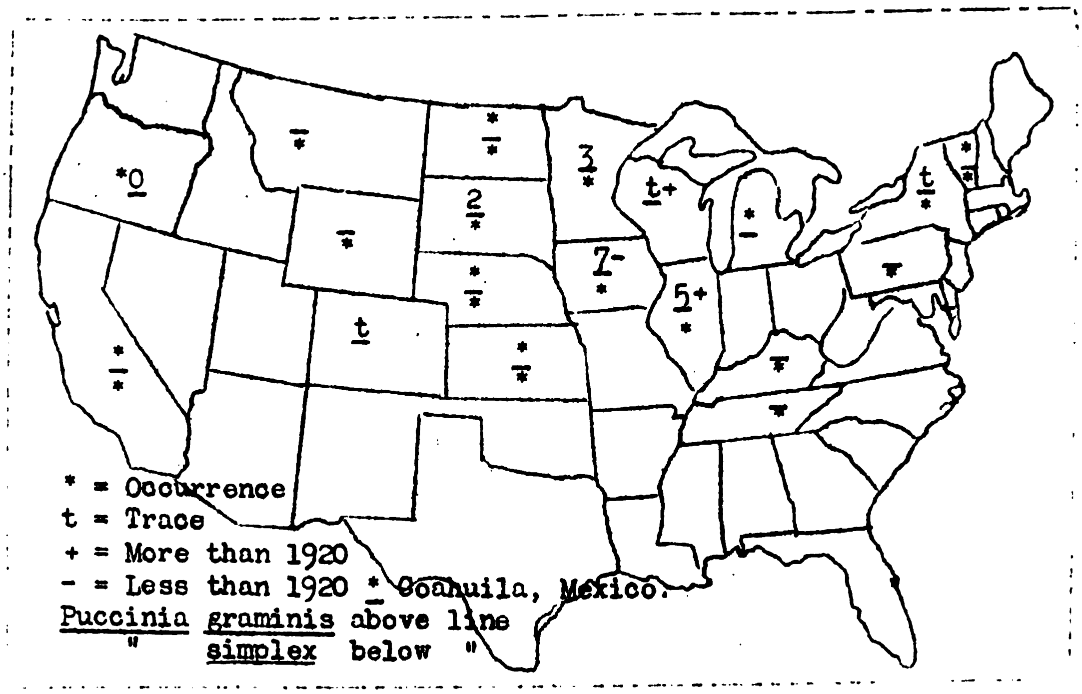


Fig. 53. Occurrence of stem rust (Puccinia graminis) and leaf rust (Puccinia simplex) of barley during 1921.

Net blotch caused by Helminthosporium teres Sacc.

Helminthosporium teres was observed in eleven states: New York, Illinois, Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Montana, Colorado, Oregon, and California. Melhus estimated that the net blotch reduced the yield in Iowa by 5%. Evans reports that he had seen a dozen fields in South Dakota in which this disease had completely ruined the crop, and he estimates the reduction in yield for the state at 3%. The maximum percentage of the disease which he found in any one field was 100. The disease also was destructive in certain localities in Oklahoma as is indicated by the following memorandum from Dr. H. B. Humphrey to Dr. G. R. Lyman:

> (Referring to specimens from Robert Stratton, station plot.)
>
> "Specimen No. 7 consists of barley plants affected with net blotch. These specimens represent an unusually serious attack and if they are representative of the condition of the barley field from which they were taken, my recommendation would be to plow the whole thing under, in order to avoid the possible further spread of spores from such diseased material. Helminthosporium teres, as you know, has its perfect stage in a species of Pleospora."

Net blotch evidently was unimportant in the other states from which it was reported; only in Iowa, South Dakota, and in some localities in Oklahoma was it really destructive.

Stripe caused by Helminthosporium gramineum Rab.

Barley stripe occurred in the following states: New York, South Carolina, Maryland, Illinois, Wisconsin, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Colorado, Arizona, Idaho, Oregon, and California. It reduced the yield by 5% in Iowa and Utah; 3% in Arkansas; 2% in Minnesota and in South Dakota; but in all of the other states the losses were less than 1%. In South Dakota the highest percentage of diseased plants observed in any field was 30, while in Minnesota in one field 25% of the plants were affected, and in Indiana the maximum found in any one field was 5%. In Wisconsin, according to Vaughan, the disease was not important enough to warrant a campaign for seed treatment. Bolley observed that the disease has never been destructive in North Dakota and that it was seen only a few times in 1921. He states, however, that it could become quite destructive if barley culture were intensive or continuous. The following reference to an article by H. C. Miller and E. Molz may be of interest.

H. C. Miller and E. Molz. Ueber die Streifenkrankheit der Gerste und ihre Bekampfung auf Grund neuer Versuche. Deutsche Landw. Presse 48: 419. July 16, 1921.

Spot blotch caused by Helminthosporium sativum P. K. & B.

Spot blotch was observed in New York (trace), Louisiana (trace), Michigan (common), Wisconsin (very slight), Iowa (trace), Minnesota (damage considerable, but estimate of percentage reduction almost impossible without more accurate survey), North Dakota (unimportant), Nebraska (moderate infection), Arizona (trace), Oregon (rare - no loss), and California (minor importance). Vaughan observes that in Wisconsin the disease was less prevalent than last year or than in an average year. He states that the injury is caused not only by the spotting of the leaves but also by seedling blight. In Minnesota also the disease is widespread both on the leaves and on other parts of the plant. The greatest damage is done by the attacks on roots, culms, leaves, and heads. The leaf spotting is only of minor importance compared with the effect of the root and foot rot and head blight. It is quite likely that the losses caused by this disease have been underestimated. The writer has seen many fields throughout the barley-growing regions of the central part of the United States in which serious damage was done by the disease. It was observed at the Minnesota Experiment Station by Hayes and others that some varieties of barley could not be grown profitably on a commercial scale on account of their susceptibility to Helminthosporium sativum. The rough-awned Manchuria barley is quite resistant to the disease, whereas, the smooth-awned Lion is extremely susceptible. Crosses have been made between the Manchuria and the Lion and some of the segregates combined the resistance of the Manchuria with the smooth-awned character of the Lion. There are great differences in the susceptibility of different varieties to the disease. A few of them are so susceptible that they do not head when the disease is epidemic. Some were observed in field plots at the Minnesota Station during this past summer on which symptoms resembled almost exactly those of the rosette (so-called take-all) of wheat in Illinois. While the spot blotch itself may be of rather minor importance it is the opinion of the writer that Helminthosporium sativum, on account of the fact that it causes a very destructive seedling blight as well as lesions of other parts of the plants of wheat, barley, and rye and many grasses, may be a very virulent and dangerous parasite. Control probably will be accomplished by the production of resistant varieties.

(Hayes, H. K. and E. C. Stakman. Resistance of barley to Helminthosporium sativum. Phytopath. 11: 405-411. Oct. 1921. (Feb. 1922).)

Scald caused by Rhynchosporium secalis (Heins.) Davis

Barley scald was reported only from Idaho, Washington, Oregon, and California. It apparently did not do much damage except in California, where the disease caused a reduction in yield of 10%, according to Mackie. Mackie states further that the disease injured all early-sown barley which he saw in field varieties in the Sacramento Valley, but the late sown varieties were less affected. Mackie mentions that Tennessee Winter barley, which is resistant to scald, is also able to survive excessive quantities of water in contrast to the common, or Coast barley which is severely injured under the same conditions. Heald and Dana state that in Washington blue barley was severely affected while adjacent plots of Tapp winter were not injured. Barss says that only winter varieties were found to be diseased in Oregon. Hungerford made observations on College Farm in Idaho, and found that the varieties were affected as follows: Wisconsin 57.9 to 65%, Tennessee Winter 15%, Michigan Winter 15%, and White Winter 15%. The yield of the Wisconsin variety was materially reduced, according to Hungerford.

Root rot caused by Fusarium sp

According to Mackie a species of Fusarium has been causing a destructive root rot of barley in California. The following excerpt is from a letter from him to G. R. Lyman:

> "In nearly all the wheat and barley fields visited this year south of Davis, I found a Fusarium root rot causing more or less damage. In some instances the damage has been estimated at 20% of the crop. The damage usually is about 5% or less. The presence of the disease in the field is found to be indicated by the weakening of the culms, the death or early maturity of the plants and shrivelling of the kernels. The characteristic pink color on the roots and up some distance on the culms was found in nearly all instances. Inspection of samples under the microscope developed true Fusarium conidia. My identification was confirmed by Prof. E. H. Smith."

A seedling blight of barley caused by Fusarium culmorum, variety leteius, was described in an abstract by Jessie P. Rose. (Rose, Jessie P. A seedling blight caused by Fusarium culmorum var. leteius Shear. (Abstract). Phytopath. 12: 28. Jan. 1922.

Miscellaneous diseases

Anthracnose caused by Colletotrichum cereale Manns. Taubenhaus reported that there was a trace of this disease in Texas.

Powdery mildew caused by Erysiphe graminis DC. - reported to be very prevalent in New York where, on account of the early warm spring, the damage reached 1.5%, according to Kirby; and was reported once in Oregon, in a moist draw in a field at Moro.

Leaf spot caused by Septoria passerinii Sacc. This has been reported from Wisconsin. (Weber, George F. Studies on Septoria diseases of cereals and certain grasses. (Abstract). Phytopath. 12: 44. Jan. 1922.)

Ergot caused by Claviceps purpurea (Fr.) Tul. Ergot of barley was found in Wisconsin, Iowa, Minnesota, North Dakota, and Montana. While it was present in several fields in some of these states, it was not found in amounts sufficient to be of economic importance.

Scab, caused by Gibberella saubinetii (Mont.) Sacc., was observed in Illinois, Wisconsin, Iowa, and Minnesota. In Minnesota the disease was fairly widespread, but did not cause any appreciable damage. The head blight is fairly common on barley, but it very seldom reduces the yield.

OATS

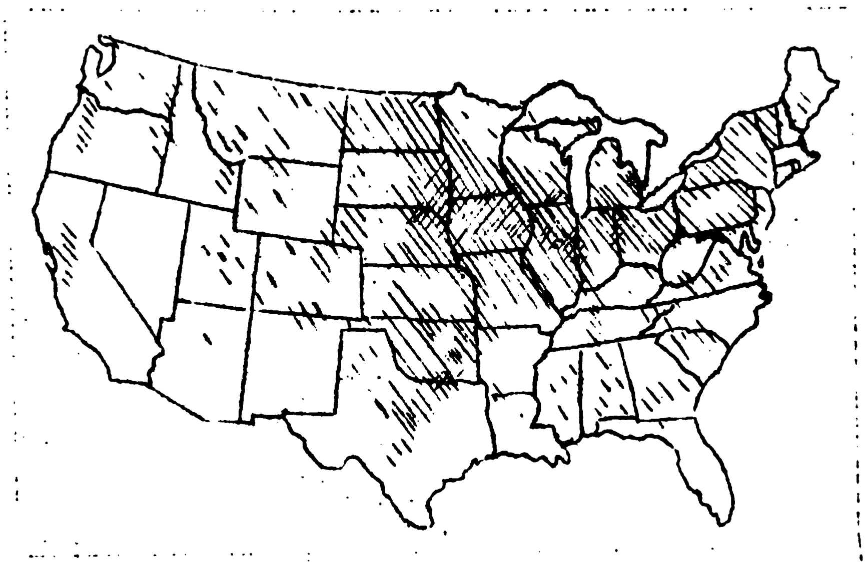


Fig. 54. Distribution of oats in the United States. (Map prepared in the Office of Farm Management.)

Smuts caused by Ustilago avenae (Pers.) Jens. & U. levis (K. & S.) Mag.

It is quite evident that the two smuts of oats, which are not separated in the survey, still do a great deal of damage in spite of extension campaigns for seed treatment. The map, Fig. 55, shows the distribution and percentage of reduction in yield due to oat smuts. The greatest losses apparently occurred in Texas and Arkansas. In both of these states it is estimated that the yield was reduced by 10% or more on account of smut. In Kentucky the yield, according to Valleau, was reduced by 8%. According to Ludwig, 7% is estimated as the reduction in yield for South Carolina; 6% in Oklahoma according to Stratton; and

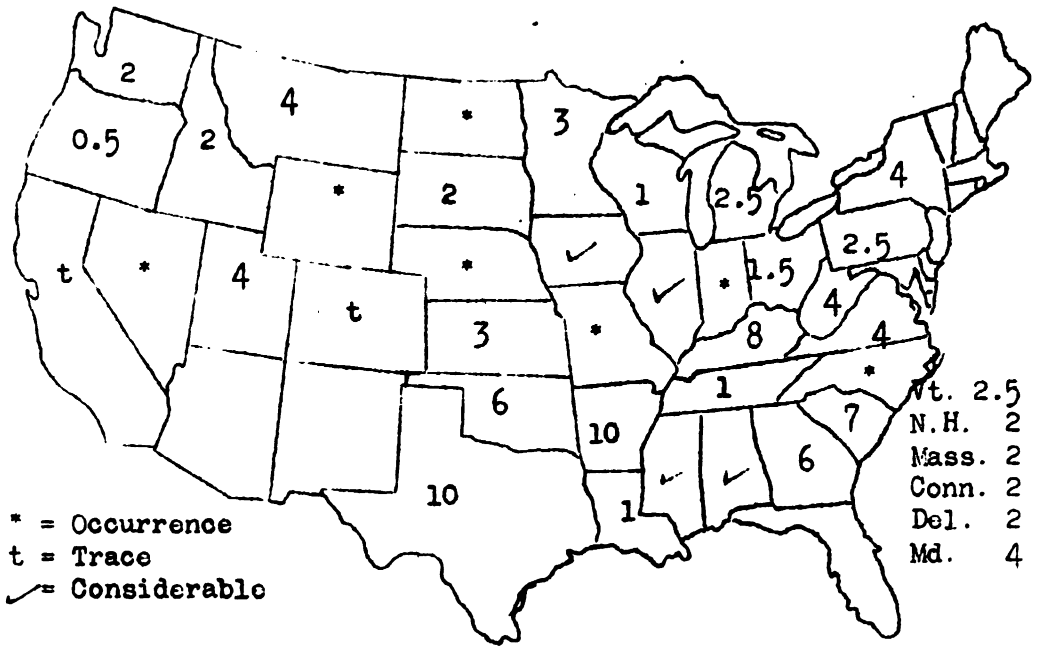


Fig. 55. Percentage reduction in yield caused by smuts of oats.

4% in Montana, according to Jennison. The highest percentages of smut found in individual fields are as follows: In Washington 40%, Indiana 35%, Kansas and Arkansas 30%; Vermont 20%, Maryland 20%, Connecticut, Kentucky, and South Dakota 15%. It is noteworthy that collaborators volunteer the information that in some states where the smut is very prevalent seed treatment is rarely ever practiced. For instance, both Valleau and Elliott comment on the fact that seed treatment is rather rare in their respective states. The percentage of smut in Kentucky was 8, while Elliott and Rosen state that it was 10% in Arkansas. Collaborators report that seed treatment is practiced commonly in New York, North Carolina, Ohio, Michigan, and Oregon. Barss says that seed treatment is so generally used in Oregon that smut is not commonly troublesome. Apparently soil conditions determine to a certain extent the amount of smut which develops in a crop. The relation of temperature, soil moisture and oxygen to the germination of the spores of *Ustilago avenae* and *U. levis* are given by Edith Seymour Jones in a brief summary, published in abstract form. (Abstract). Phytopath. 12: 45. Jan. 1922.

The results of experiments with chlorophol, a new disinfectant, are summarized by Tisdale as follows (Cereal Courier 13: 280-284. Dec. 30.):

> "Chlorophol, a new disinfectant which was tested on smutted seed of *A. nuda* for controlling both oat smuts, gave almost perfect control with very little or no seed injury."

Other work on seed treatment is reported by Lambert and Bailey (2), and by Howitt and Stone (1); and L. J. Stadler writes in the Cereal Courier as follows:

The results of our preliminary tests of the effects of various formaldehyde treatments for oat smut are reported below. The object of this test was to obtain preliminary information on the effect of the various formaldehyde treatments now recommended by different stations on the yield of oats, aside from their effect in controlling smut. The treatments were therefore applied to Burt oats, which are commonly free from smut under our conditions. No smut was found in this plat either in the treated or the untreated rows. Five treatments were used in comparison with an untreated check, and the six lots of seed were each sown in single rod rows replicated twenty times. The order of treatments was the same in each series. The yields were as follows:

Method	Yield, bu. per acre
Illinois (Ill. Circ. 240)	50.3 ± 0.98
Old treatment, oats covered 14 hrs. (Farmers' Bul. 939)	54.8 ± 1.00
No treatment	48.3 ± 1.09
Old treatment, oats covered 5 hrs.	54.1 ± 1.00
"Iowa" treatment (Iowa Circ. 45.)	52.9 ± 0.97
Atomizer method (Phytopathology 7: 381-383.)	53.9 ± 1.31

None of the treatments noticeably affected the germination of the seed as determined either in germination tests or from the stands in the field. Apparently significant increases in yield were caused by most of the treatments, though of course several more trials must be made before any definite conclusions can be drawn. (Stadler, L. J. (Columbia) Cereal Courier 13: 288. Dec. 15.)

Fromme made some observations on varietal resistance, and the results summarized as follows:

General and about the same as usual in severity. Winter varieties, all seed untreated showed following percentages in Experiment Station plots: Virginia Grey, 15%, Fulghum 5%, Bancroft 5%, Appler 3%, and Red Rust Proof, 0."

Literature cited

Howitt, J. E. and R. E. Stone. Experiments with Haskell's method or the so-called dry formaldehyde treatment for the prevention of oat smut. (Abstract). Phytopath. 12: 35. Jan. 1922.

Lambert, E. B. and D. L. Bailey. Results of treating seed of spring wheat and oats with copper carbonate dust to prevent smut. (Abstract). Phytopath. 12: 36. Jan. 1922.

Stem rust caused by <u>Puccinia graminis</u> Pers.

Stem rust evidently was not as generally distributed as crown rust, as will be seen by the accompanying map (Fig. 56). Neither did the stem rust cause such great reductions in yield. However, it was quite generally present in the more northern oat-growing states. In the extreme South the stem rust seems to be much less important than the crown rust, while in the northern states, stem rust did the greatest damage. In Michigan and South Dakota, for instance, stem rust is reported to have reduced the crop by 10%, while in Minnesota the loss was about 5%. (See map, Fig. 56, for losses.)

Stem rust was found by Butler and Christopher on <u>Phalaris caroliniana</u> and <u>Lemnodia arkansana</u> in Texas and Oklahoma. Apparently both of the oat rusts are quite generally distributed on these hosts in the South.

A rather remarkable fact in connection with the distribution of these two rusts is brought out by Edgerton who states that he never has seen stem rust in Louisiana, although crown rust sometimes makes it impossible to grow oats successfully in that state. No explanation can be offered for this except that from the results of studies so far made in the rust epidemiology work, it seems that the urediniospores of crown rust are capable of over-wintering more easily than are those of stem rust. Differences in varietal susceptibility possibly may account for the distribution of the two rusts.

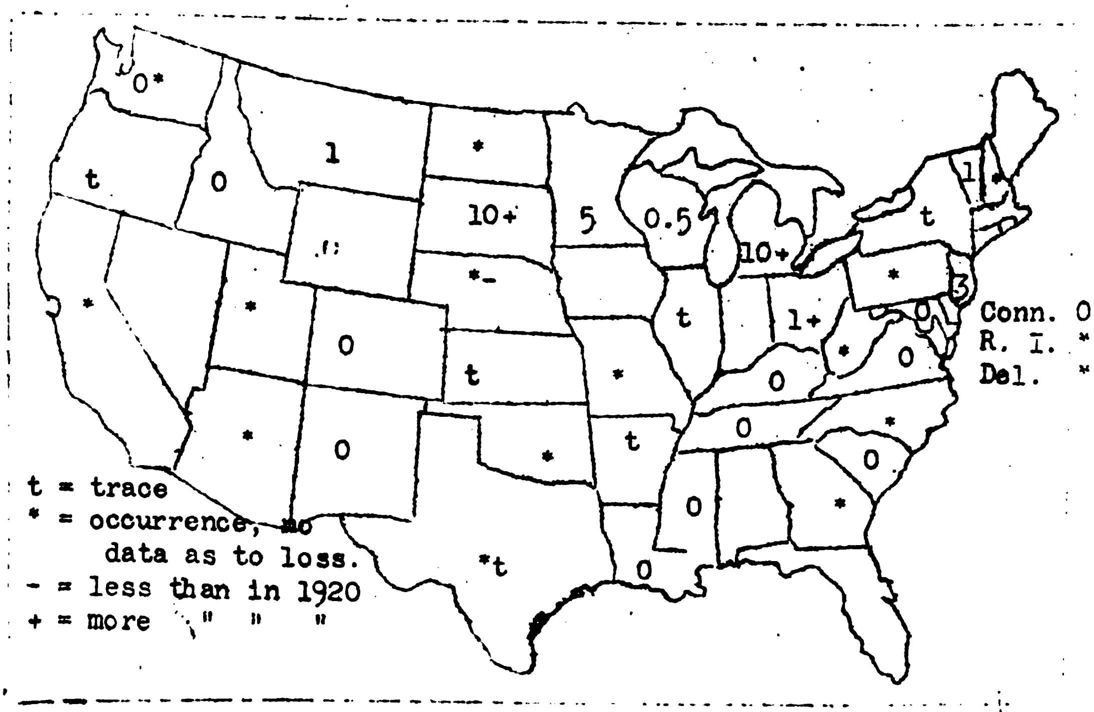


Fig. 56. Losses from stem rust of oats, 1921.

It scarcely seems that temperature relations are the determining factor, since stem rust is sometimes fairly heavy in Texas.

In the northern states White Russian oats are very resistant. The ordinary spreading panicle oats very frequently are heavily rusted while adjacent fields of White Russian are practically free from rust. An important study of the inheritance of resistance in crosses between resistant White

Russian and susceptible spreading panicle oats recently has been made by Garber and a preliminary note has been published (2). The results of varietal tests also are given by Durrell and Parker (1).

Literature cited

1. Durrell, L. W. and J. H. Parker. Comparative resistance of varieties of oats to crown and stem rust. Iowa Agr. Exp. Sta. Res. Bul. 62: 27-56d. Illus. Oct. 1920 (Oct. 1921).
2. Garber, R. J. A preliminary note on the inheritance of rust resistance in oats. Jour. Amer. Soc. Agron. 13: 41-42. Jan. 1921.

Crown rust caused by Puccinia coronata Cda.

Crown rust, caused by Puccinia coronata, occurred practically wherever oats are grown. It was by far the most injurious, however, in the southern states. Neal reports that in Mississippi the crop was reduced by at least 4%, while Edgerton states that in Louisiana the reduction was 20%, and Tauhenhaus gives the same estimate for Texas. Elliott estimates a 10% reduction in yield in Arkansas. In the other states the losses were considerably less. (See map, Fig. 57.)

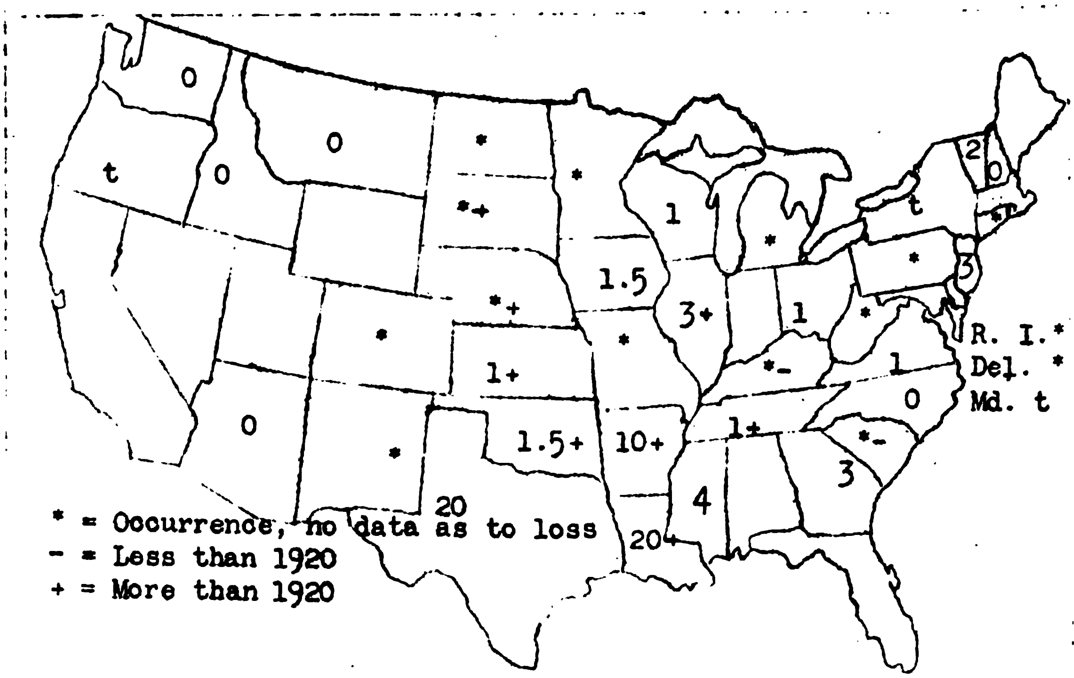


Fig. 57. Estimated percentage loss from crown rust of oats, 1921.

Apparently the urediniospores of the rust overwintered in the South this year. Crown rust was fairly abundant at Brownsville, Texas, in January, and had appeared at Dallas, Texas on April 9. By the middle of May there was a heavy epidemic on oats in the general region of Dallas. In Texas and Oklahoma rust was found to be fairly prevalent by Butler and Christopher on *Phalaris caroliniana* and *Lemnodia arkansana*. These grasses, as well as several others may

enable the uredinial stage of the rust to overwinter. The rust attacked the oats early in the South. Edgerton states that in Louisiana crown rust sometimes injured plants so severely that they did not head. He also observes that much seed was brought in from Texas, all of which was severely injured. Home grown seed was not so severely injured. Taubenhaus states that the Texas Red Rust Proof was decidedly susceptible this year, possibly due to the wet season. Melchers comments that for the first time since 1913 there was a tendency for the production of a real epidemic of crown rust in Kansas. The estimated reduction in yield is indicated on the map, Fig. 57.

It is interesting to note that several collaborators comment on the effect of buckthorn on the severity of rust. Browning states that in Rhode Island buckthorn is very common and abundant and aecial cups were noted early in the spring. Coons states that rust was very common and destructive in Michigan and that the native Rhamnus alnifolia was found to be rusted. Vaughan comments as follows: "In the vicinity of Rhamnus hedges in Dane and Rock Counties (Wisconsin) oats were almost a complete failure." In southeastern Minnesota the effect of Rhamnus on the destructiveness of crown rust also has been noted. The wild Rhamnus alnifolia which is common in swamps often is heavily rusted, but apparently much of the rust on this host transfers to Calamagrostis canadensis but not to oats.

During the year several important publications have appeared. Hoerner has shown that the crown rust from oats can infect one or more species of the following genera of grasses: Agropyron, Alopecurus, Anthoxanthum, Arrhenatherum, Avena, Bromus, Dactylis, Elymus, Festuca, Holcus, Hordeum, Hystrix, Lolium, and Phleum, and Durrell and Parker have summarized the results of varietal tests.

Recent literature

Durrell, L. W. and J. H. Parker. Comparative resistance of varieties of oats to crown and stem rusts. Iowa Agr. Exp. Sta. Res. Bul. 62: 27-56d. Illus. Oct. 1920 (Oct. 1921).

Hoerner, G. R. Germination of aeciospores, urediniospores and teliospores of Puccinia coronata. Bot. Gaz. 72: 173-177. Sept. 1921.

__________ Miscellaneous studies on the crown rust of oats. Amer. Jour. Bot. 8: 452-457. pl. xxiv. Nov. 1921.

__________ Infection capabilities of crown rust of oats. (Abstract). Phytopath. 12: 33. Jan. 1922.

Halo-blight caused by Bacterium coronafaciens Elliott (= Pseudomonas avenae Manns)

Halo-blight was observed in thirteen states during the past year (see map, Fig. 58). It was fairly generally distributed throughout the country, except in the New England states and in the extreme South. It was recorded from Delaware, Kentucky, North Carolina, Arkansas, Ohio, Wisconsin, Minnesota, South Dakota, Iowa, Nebraska, Montana, Colorado, Idaho, and California. Apparently the halo-blight was quite prevalent but relatively unimportant. It was reported as having been very prevalent in Kentucky, North Carolina, Arkansas, Minnesota, South Dakota, and Montana. In Minnesota as many as 95% of the plants in individual fields were affected. In Montana apparently the disease was prevalent enough to cause some concern in the early summer. However, according to Jennison, it

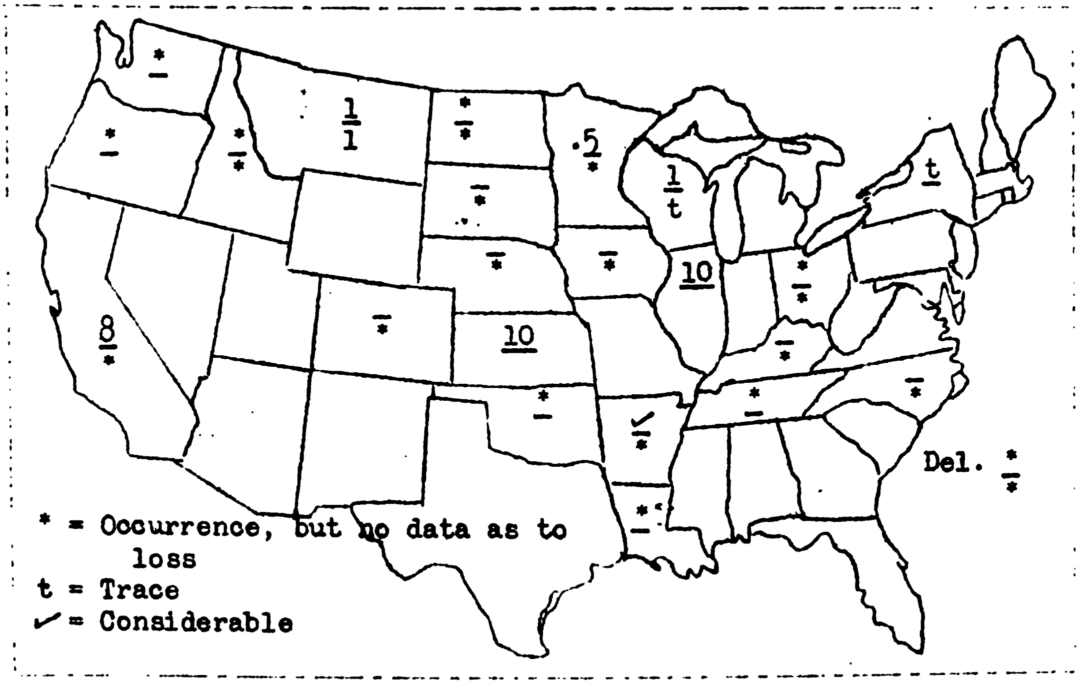


Fig. 58. Losses from blast (upper figures) and halo-blight (lower figures) of oats in 1921.

was checked by hot weather and caused a reduction in yield of only 1%. Various other collaborators comment on the fact that the disease was quite prevalent early in the season but that its spread was checked by the advent of hot, dry weather. Except Montana, where the yield was reported to be reduced by 1%, the damage was apparently negligible.

Blast (sterility) cause not determined

Oat blast was widely distributed through the country, as is shown on the accompanying map, Fig. 58, on which the occurrence of halo-blight also is recorded. The blast was most prevalent and did the greatest damage in Arkansas, Illinois, Kansas, and California. In Kansas as many as 80% of the heads were affected in one field. In most of the other states besides those already mentioned the disease occurred, but apparently did not do very much damage. Some observations are made by collaborators on the effect of weather on development of blast. Heald and Dana state that, according to Frank, there is much blast in western Washington each year, due to nutritional or climatic causes. Bolley suggests that it is associated with intensely hot weather just at the period when the flowers are being pollinated in the sheath, and Vaughan states that in Wisconsin the occurrence of blast is correlated with the emergence of the head from the boot in rainy weather. Apparently anything which interferes with pollination or fertilization is likely to cause blast.

Anthracnose caused by Colletotrichum cereale Manns

The anthracnose of oats was reported only from North Carolina, Ohio, and Minnesota. The disease did practically no damage in any one of these states.

Foster states that the disease was unimportant in North Carolina, and the same was true in Minnesota. In Ohio the disease was said to be of only slight importance.

Scab caused by Gibberella saubinetii (Mont.) Sacc.

It is quite evident that scab occurs only rarely on oats. It was reported only from Illinois, Iowa, Minnesota, Missouri, and North Dakota. Tehon and Dungan state that it was slightly more prevalent than usual in Illinois. In Minnesota there was a trace. Hopkins states that in Missouri there were several fields in which 50% of the plants had one or more infected spikelets. Frear writes, in a letter to the Plant Disease Survey that, in the inspection of fields in the pure seed work in Missouri, it was necessary to reject many fields on account of the prevalence of scab. Bolley and Weniger state that in North Dakota seedling blight was reported twice. They do not state whether the head blight occurred. It is quite likely that the scab head-blight occurs fairly commonly, although only in relatively small amounts. No detailed information was furnished regarding the seedling blight caused by the scab organism.

Miscellaneous diseases

Leaf spot caused by Septoria avenae Frank (see Weber, George F. Studies on Septoria diseases of cereals and certain grasses. (Abstract). Phytopath. 12: 44. Jan. 1922.)

Leaf mold caused by Cladosporium sp. - reported from Washington by Heald, Dana, and Frank.

Powdery mildew caused by Erysiphe graminis DC. - reported from Washington by Heald, Dana, and Frank; and from Coos County, Oregon by Barss.

Red leaf, probably due to cold and drought, reported by Fromme as being general in a field in Brunswick County, Virginia. According to Barss, it was more or less general in western Oregon, where it was apparently associated with soil and weather conditions.

Root rot, cause not determined, reported from Ohio as follows:

> This apparently is a new disease of oats that has been brought to our attention for the first time this year. The field characteristics are a stunting and yellowing of the plants. It appears in irregular spots in the fields. When diseased plants are pulled up the root system is found to be very scanty, with a few remaining roots in a much decayed condition. The trouble was reported by Mr. Cave, the Fulton County Agent. Growers having this disease state that the same spots appear in the fields each year that oats are planted. Other crops such as corn, wheat, and clover, are not affected. (Clayton).

Frost and drought injury is reported from Washington and Missouri; probably also occurs in a number of other states. The intensely hot weather and accompanying drought in many regions undoubtedly was responsible for reducing the yield materially. Selby states that this was the most important factor for reducing the yield in Ohio.

CORN

Fig. 59. Distribution of corn crop in the United States. (Map prepared in the Office of Farm Management.)

Smut caused by Ustilago zeae (Beck.) Ung.

Corn smut in general was much more prevalent in 1921 than it has been for some years past. This is not true for all of the states, nor does it seem to be true for any particular region, but many collaborators comment on the fact that an unusually large amount of smut developed. In Rhode Island only a few specimens were obtained, all of which were on Golden Bantam. Clinton reports that in Connecticut there was about the usual amount, and that in Dr. Jones' breeding plots certain strains were quite resistant and others susceptible, and that these characters seemed to be inherited. Bolley calls attention to the fact that the smut was quite common in certain fields in North Dakota, in a region which is rather new to corn, and suggests that either the spores must be carried long distances by the wind or the crop is infected by the use of diseased seed. Wind distribution probably easily could account for the appearance of the disease in new regions since large numbers of smut spores were caught at elevations of several thousand feet in the air, and since they are known to retain their viability for a long time. The greatest reduction in yield due to smut was reported from North Carolina where it was estimated as 20%. Evans estimates the reduction in yield in corn for South Dakota due to smut as 15% and comments as follows:

> "Corn smut very bad. Never saw it worse. Many farmers declare it has ruined crops. No field free. Evidently excellent weather conditions when air conidia were distributed."

Learn states that in Colorado corn smut is becoming more prevalent each year and that in Lincoln and other counties the county agents report that it is very destructive. In Minnesota the smut unquestionably was much more prevalent and destructive than it has been for many years, although it is doubtful whether the yield was reduced by more than 2 or 3%. Many farmers and county agents

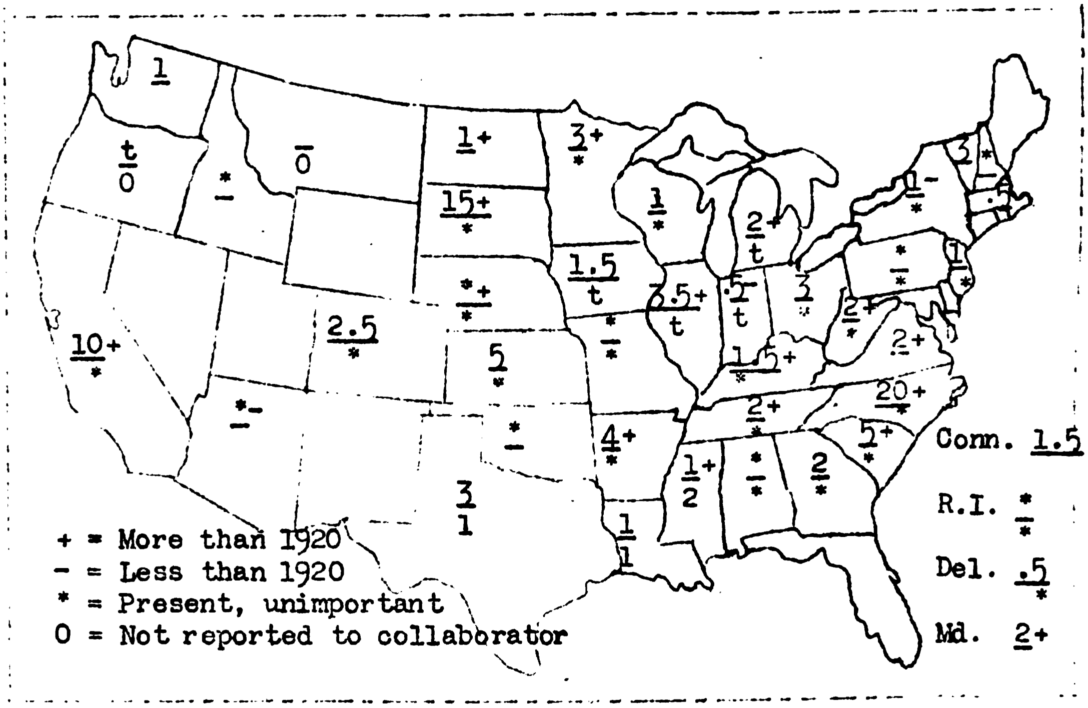


Fig. 60. Occurrence of and percentage losses from smut (upper figures) and rust (lower figures) of corn, 1921.

commented on the fact that in many fields as high as 75% of the plants were affected. The smut was so prevalent that fields appeared to be spotted with black when viewed from a railroad car window. (For losses and distribution see Fig. 60.)

There are differences in varietal susceptibility; even some farmers reported that they had observed differences. Cooperative experiments between the plant breeding and plant pathology departments at the University of Minnesota have been carried on for several years and it has been definitely established in corroboration of Jones' results at Connecticut, that there are differences in varietal susceptibility, and it seems that it will be quite possible to produce smut resistant varieties.

Just why the smut was so much more prevalent in many states this year than for several years past, cannot be explained easily. It would seem that in many localities the weather conditions were unfavorable for the development of the disease. However, this can scarcely have been true, since the fact of the unusual prevalence of the disease is unquestioned.

Rust caused by Puccinia sorghi Schw.

The rust of corn was very generally distributed. It was reported from most of the states in which corn is grown - from Rhode Island to California, and from Minnesota to Louisiana. It probably was almost universally present, although in the aggregate it causes very little injury. Browning states that in Rhode Island there was much less rust than there was last year but that there was a rather high percentage on Evergreen Bantam. Other varieties, according to Browning, were almost free from the disease. Neal states that in

Mississippi the disease was important locally, being rather severe in Adams County. He estimates that the yield for the state was reduced by 2%. Edgerton calls attention also to the seriousness of the disease in Louisiana. It was universally prevalent in the state, according to Edgerton, and caused death of leaves and sterility. Edgerton estimated that the reduction in yield for the state was about 1%. In Texas the rust apparently also did some damage. Taubenhaus estimates that the loss probably was 1%. In all of the other states, however, only a trace is reported, although many collaborators comment on the fact that the disease was unusually prevalent during the past season.

Root, stalk & ear rots caused by various organisms

Corn root, stalk and ear rots were quite prevalent and destructive during the past year. The accompanying map (Fig. 61) shows the distribution and the estimated reduction in yield. Fromme states that in Virginia the

Fig. 61. Occurrence of and percentage loss from corn root, stalk and ear rots caused principally by Fusarium spp. Shaded area indicates region in which the disease is most important.

symptoms were not so evident as in previous years, but that the disease was present to some extent in all fields and that it was particularly prevalent in the Shenandoah Valley. Valleau comments that in Kentucky the disease is coextensive with the crop, but that it is extremely difficult to estimate the losses from this type of disease. He states that the injury was serious where

there was insufficient moisture and food for the best growth of the corn plants, and that these diseases probably are of slight importance when the corn plants are growing under most favorable conditions. Holbert comments as follows on the situation in Illinois:

> Mr. S. D. Fessenden of the Bureau of Crop Estimates in speaking of Illinois corn conditions among other things, says "Barren stalks are found unusually common, and badly filled ears are making great inroads into the individual estimates of farmers on their own crops." The organism connected with this type of trouble has been isolated in great abundance this year and is probably responsible to an appreciable extent for the numerous barren stalks and stalks producing nubbin ears. Harvest data taken on 1740 stalks inoculated with this organism show approximately 25% reduction in the total field weights. The data also show that certain varieties of dent and sweet corn are much more susceptible to this malady than others. (J. R. Holbert. Cereal Courier 13: 241. Oct. 20, 1921.)

In Minnesota the root rot was fairly common in the southern part of the state, but apparently it did but little damage. It was observed that the disease was most destructive on poorer soils, and that when the corn was growing under favorable conditions root rots seemed to be of very slight importance. The disease was found in Idaho although, according to Hungerford, only one or two cases were reported and apparently it is of little importance.

Etiology of root rots

The etiology of the corn root rots is extremely important. Apparently Gibberella saubinetii and Fusarium moniliforme are most commonly associated with the disease. Edgerton states that in Louisiana Fusarium moniliforme is very common but that he has been unable to form any conclusion as to the damage it does to the crop. Holbert also states that F. moniliforme occurs commonly in Illinois, particularly following the ravages of the corn ear worm. He says that selections of Reid's Yellow Dent corn show wide variations in susceptibility to ear rot. The following summary on the etiology of these diseases was prepared by Dr. G. N. Hoffer:

> "The greater number of ear rots and root rots of corn are caused by the same organisms, but it is necessary to discuss them separately because the contributing factors which determine the extent of the damage that results to the ears and roots varies according to the parts of the plant affected.
>
> "Ear rots are dependent upon definite moisture and temperature relations, while the root rots seem to be most closely correlated with the quantities of certain nutrients and deleterious substances which are absorbed from the soil solution.
>
> "(A) Root rots: The causes of rots of the roots of corn plants must be considered in their relation to

the normal functioning of the root system and the growth of the corn plant. The life of the roots is dependent upon the ability of the green parts of the plant and the translocation tissues to maintain an adequate number of them in a healthy condition for proper functioning. Every corn plant which has reached maturity has some roots which are rotted. The difference between a healthy and a diseased plant in so far as the extent of root rotting is concerned is one of degree only. A plant is regarded as being healthy so long as the root rots do not interfere with the production of well matured ears on apparently normal stalks of an adapted strain of corn.

"Resistance to root rots is a function of the genetical composition* of the plant and of the relative availability of deleterious substances which may be present in the soil solution, or which may become available in the immediate environment of the roots at some time during the life of the plant. Other soil conditions associated with deficiencies of any of the essential nutrients may also influence the growth of the corn plant and predispose it so that the roots may become severely rotted if the pathogenes are present in the soil, and proper temperature and moisture relations prevail.

"Aluminum and ferrous-iron salts are probably the most important deleterious agents which become available in the soil solution to affect the growth of the corn plant. In many soils aluminum compounds are available in sub-toxic quantities and the rate of their accumulation and consequent effect upon the living cells in the leaf and stalk tissues of the plants seem to determine the degree of susceptibility of the plants to serious rotting of the roots. The genetical composition of the plants as reflected in their varying physiological selective absorption capacities for aluminum compounds seems to be correlated with their relative susceptibilities to root rot when sub-toxic quantities of available aluminum are present in the soil solution. When, however, the quantities of available aluminum reach toxic proportions in the soil solution, all plants, irrespective of genetical composition, respond to this toxicity and the roots become thoroughly rotted. The acidity of the soil solution and the lack of available phosphates or frequently, potash, seem to be related to this soil influence upon the plants.

*In using the term genetical composition it is understood that the commercial varieties of corn represent combinations of strains which can be isolated by inbreeding. Inbred strains have been produced which show all gradations of susceptibility to root rots.

"The organisms which have been isolated from rotted roots on both "diseased" and "healthy" plants are most commonly Fusarium moniliforme, Diplodia zeae, Gibberella saubinetii, and Penicillium sp. The severity of the root rots caused by these organisms is dependent upon the relative susceptibility of the corn plant at any stage of its development, either as a seedling, a young plant, or a plant which has reached the post-pollination stage.

"(B) Ear rots: The development of the rots of the ears is determined primarily by the climatic complex affecting the ears and also by the condition of the stalk during the latter part of the season. If the stalks are affected by abundant root rot, the rate of maturation of the ears is inhibited. Such ears remain immature, or starchy, for a longer period, and are more affected by the ear rot pathogenes under adverse weather conditions than are those which are more matured.

"Corn ear-worms and hail may open channels of entry into the ears for the pathogenes, and thus favor an early development of the ear rots.

"The ear rots may develop irrespective of the serious rotting of the roots of the plants on which the ears are borne. The resistance of plants to root rots does not guarantee freedom from infections and infestations of the ears, although the ears which are borne on healthy stalks are more likely to be better matured and hence escape the attacks of the organisms. Some of the rots may progress to such an extent as to completely decompose the kernels and produce a badly rotted ear. Other infections and infestations may be inconspicuous. None of the organisms associated with the root rots have been found to be systemic to date, and consequently the ear rots are not caused directly by the growth of the organism from the roots upward through the stalk and shank.

"The pathogenes responsible for causing ear-rots and ear-infestations are Diplodia zeae, Gibberella saubinetii, and Fusarium moniliforme. Their importance as agents causing seedling blight depends upon the injury they do to the kernels before planting, as ear-rot organisms, and the relative resistance of the seedlings as determined by their genetical composition when they grow from kernels on ears which are thoroughly matured but infested by the organisms. Some ears may not be infested by any of these organisms, yet when planted will produce a high percentage of seedling blight and stalks with rotted roots. Other ears which are infested may give perfect stands and productive plants.

"Unless actual injury to the kernels on the ears has occurred the importance of seed infestations varies with the different strains of corn. The strains which are most affected by deleterious substances in the soil are the ones most seriously injured by seedling blight as well as by a rotting of the roots later in the season.

Summary

"From our present knowledge of root rots, it appears that they are primarily the resultant of the effects on corn plants of unbalanced supplies of available nutrients in the soil. Under such conditions plants are rendered more or less susceptible according to their varietal and genetical composition. When the soil environment is made physically and chemically favorable and uninfected seed of good strains planted, root rots are of little consequence because of the inability of the organisms which are commonly present in the soil to make progress in causing serious root rots even though the temperature and moisture relations are favorable for the development of root rots."

Control of root and ear rots

Very evidently control measures consist in the development of resistant varieties, careful seed selection, rotation of crops, maintenance of soil fertility, and various other cultural practices. Branstetter made some experiments in Missouri which are summarized in part as follows:

> Rows planted from heavily, moderately, and lightly infected seed averaged respectively 27.4, 16.4 per cent of diseased plants while seed from the same lots disinfected averaged respectively 15.5, 12.5, and 8.9 per cent of the diseased plants. This indicates first, that the relative amount of disease in the field is roughly proportional to the root rot shown on the table germinator; and second, that disinfection of the seed as above described materially reduces the amount of root and stalk rot in the field. (B. B. Branstetter. Treatment of seed to control root and stalk rots. (Abstract). Phytopath. 12: 30. Jan. 1922.)

The effect of seed selection is shown by the following excerpts:

Illinois: In the plants which have been harvested so far, the disease-free seed has yielded much better than the diseased seed, the highest yielding disease-free producing at the rate of slightly over 100 bushels to the acre." (J. R. Holbert. Cereal Courier 13: 230. Oct. 10.)

Kansas: The plats of Pride of Saline corn planted from relatively disease-free ears made a significantly higher yield than those planted from diseased ears, while in the case of Midland Yellow Dent the difference in yield of the two plants was probably not significant. (John H. Parker. Cereal Courier 13: 292-293. Dec. 15.)

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Bacterial wilt caused by *Aplanobacter stewartii* (EFS) McCul.

The present status of bacterial wilt of sweet corn is well summarized in an article by Rand and Miss Cash (Rand, F. V., and Lillian C. Cash. Stewart's disease of corn. Jour. Agr. Res. 21: 263-264. May 16, 1921). The following is a brief summary of the article:

> Found in Georgia, South Carolina, Tennessee, Virginia, Kentucky, Missouri, Iowa, Illinois, Indiana, Ohio, Pennsylvania, District of Columbia, Maryland, Delaware, New Jersey, southern New York, and Connecticut. Reported by other pathologists from Massachusetts, West Virginia, Michigan, Oklahoma, New Mexico, and California.
>
> Arrangement of varieties according to time of maturity coincides almost exactly with arrangement according to percentage of wilt development. Later varieties show lowest percentages (average below 10%); earliest varieties under same conditions show serious losses (average 25-57%).
>
> No evidence of infection from soil or from proximity to diseased stalks obtained; but organism isolated from endosperm of seed from diseased plants.
>
> Infection of young plant from seed dependent on growth conditions during first two weeks - soil moisture, texture, fertility, and temperature, particularly soil moisture.
>
> Results indicate that northern-grown seed is less likely to carry infection than that grown farther south, and that infected seed may be rendered safe for planting by a dry heat pasteurization at 60° to 70° C for one hour.

During the past year the disease was reported in Maryland, Virginia, Tennessee, North Carolina, Ohio, Indiana, Illinois, and South Dakota. Apparently it did no appreciable damage in most states. The loss is estimated as only a trace in all except in Maryland in which it is estimated as 1%. It was particularly abundant on Golden Bantam corn, especially in fields which had been planted early.

Brown spot caused by *Physoderma zeae-maydis* Shaw

This disease was most prevalent in the southeastern states and some of the states of the Ohio Valley. It was found as far west as Arkansas but did not occur to any extent in the more northern corn-growing states. The damage in the individual states was only a trace, although it was locally destructive. In Georgia, according to McClintock, the disease was serious but no definite figures indicating percentage of reduction in yield are available. Burger states that in Florida the disease was locally very destructive and he comments as follows:

> "My observations are that in the southern part of the state the disease is not very severe. I believe that this is due to the fact that the corn is planted early and is matured before the rainy season comes on. However, in the northern and western parts of the state where the corn does not mature until after the rainy season, I find a considerable amount of damage being done. I visited a field in the northern part of the state where there was only a slight amount of spotting at the end of May. The spotting was so slight that I had to hunt through the corn field to find it. I went back to this field on about the 15th of July, the month of June having been somewhat rainy, and I found at that time the corn badly affected. The leaf and stalk showed that in two months' time this disease had so badly spread that much damage was found. In a neighboring field in Alachua County, on July 15 I found a lot of corn so badly affected that the stalks were breaking off about six inches from the ground, the tissue seemingly having been decayed. In many fields I found the disease on the husks about the time of ripening. In a lot of those ears where the disease was found on the husks, I found poorly developed ears, with loose grains, and I was wondering whether or not this is the one characteristic which is manifested by the disease. I also found on some ears a lot of grain poorly developed. I have kept some of this corn and hope that I will be able to plant it this coming spring and see if this corn does not carry the disease.
>
> "In Putnam County, our adjoining County, one man reported from Hawthorne that his fields were so badly affected that if he did not soon get relief or some method for control, he would have to abandon the growing of corn on his property. He states that this disease has been getting worse for the past three or four years."

In Alabama, according to Povah, the disease was much less destructive than it was in 1920, possibly on account of the dry weather.

Mosaic, cause unknown

The mosaic disease of corn was reported in 1921 from Louisiana and

Georgia, and mosaic-like troubles occurred in North Carolina and Tennessee. In Louisiana Edgerton estimated that the reduction in yield due to the disease was approximately 2.5%. The disease in that state was considered by Edgerton to be considerably more prevalent than it was last year, or than it is in an average year. McClintock states that in Georgia also the disease was more prevalent than it was last year, or than it is in an average year and that it was spreading into south Georgia. The following statements made by Kunkel indicate that the mosaic disease is important in Hawaii:

> I note that mosaic is present on corn in some of the southern states. It is one of the diseases that should be kept under observation. If it should spread to the corn growing regions of the Middle West and should there become one-half as destructive as it is in Hawaii, it would be a calamity. (L. O. Kunkel. News Notes, Office of Cotton, Truck and Forage Crop Disease Investigations. Aug. 6, page 7.)

The following summary is from Kunkel's bulletin dealing with a possible cause of corn mosaic.

> 1. A foreign body believed to be a living organism is invariably present in diseased cells of mosaic corn plants.
> 2. The body is irregular in shape and always occupies a position on or near the host cell nucleus. It usually shows a definite structure, stains like protoplasm and is frequently vacuolate.
> 3. The distribution of the intracellular bodies corresponds exactly with the distribution of the light green color in diseased leaf tissue. In the stalk, they are present in the cells of diseased tissues but absent from the cells of healthy tissues.
> 4. It is suggested that the bodies of corn mosaic may be similar to those associated with certain virus disease of man and animals.
> 5. Corn mosaic is similar to, if not identical with, the yellow stripe disease of sugar cane.
> 6. Nine varieties of sweet corn, two varieties of pop corn, and fourteen varieties of field corn have been shown to be susceptible to the disease. Several varieties are somewhat resistant but no variety is known to be immune. (L. O. Kunkel. A possible causative agent for the mosaic disease of corn. Hawaiian Sugar Plant. Assoc. Exp. Sta. Bul. 3 (1). July 9.)

Bacterial stem rot caused by Bacterium sp.

The bacterial stem rot of field corn was first described from Arkansas by Rosen (1,2). What appears to be the same disease was observed in the following states during the year: New York, North Carolina, Mississippi, Louisiana, Arkansas, Ohio, and Illinois. The collaborators from the following states

report that they have not observed the disease: New Hampshire, Vermont, Connecticut, New Jersey, Maryland, Virginia, West Virginia, Kentucky, Tennessee, South Carolina, Georgia, Texas, Oklahoma, Indiana, Michigan, Wisconsin, Minnesota, Missouri, North Dakota, Nebraska, Montana, Colorado, Arizona, Idaho, and Washington. It is quite likely that it may occur in some of these states but that it is not destructive enough to attract attention.

The bacterial stem rot did not seem to do much damage during the past year. It is listed as a trace in practically all of the states reporting it. Neal says that it occurred locally in Mississippi, while Rosen states that in Arkansas it was severe in certain places. Dungan and Tehon report that it was present in Illinois, especially in the southern part. The comment by Edgerton, among those quoted below, is especially interesting:

Louisiana: The bacterial stem rot of corn described by Rosen from Arkansas has been known in Louisiana since 1908. I saw it the first year that I was in Louisiana and have seen it to some extent nearly every year since. Some years it is very troublesome in some localities and other years, it is of little importance. There was some complaint this year on some of the reclaimed soils in south Louisiana. (Edgerton).

Ohio: A new type of stalk rot disease has been observed in Ohio. This is thought to be due to a bacterium species of organism although the identity of the causal factor has not been fully established. This type of disease has been found in different sections of the state during the seasons of 1920 and 1921. (R. C. Thomas).

Illinois: A few days ago I received two samples of corn - one from Jackson County and one from Monroe County - which showed typical symptoms of the bacterial stalk and root rot disease as described by Prof. H. R. Rosen, of Arkansas. I furnished him specimens of this disease from both of these counties and he has reported that without doubt it is the serious disease that occurs in Arkansas. It is the first occurrence of this trouble, as far as I know, in Illinois. Dr. Burrill, of course, did some work on the bacterial disease of field corn, but we are not able to learn definitely as to whether he was dealing with the same disease as the one that is showing up in these counties. (Dungan).

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2. __________ Further observations on a bacterial root and stalk rot of field corn. Phytopath. 11: 74-79. Feb. 1921.

Ear mold caused by Diplodia zeae (Schw.) Lev.

Ear mold caused by Diplodia zeae, was prevalent and destructive in 1921. It was reported only from New York, Ohio, Kentucky, Indiana, Illinois, and Iowa, but the percentage of reduction in yield was high in all states except New York,

The following are estimates of the percentage loss: New York (trace); Kentucky (8.5%); Indiana (10%); Illinois (8%); Iowa (4%). (The estimates for the last three states were made by Cromwell.) In Ohio, according to Thomas, the disease is causing serious concern, and while it was generally distributed it was most destructive in the southwestern part of the state. Valleau states that in Kentucky the disease is co-extensive with the crop. He states that there is definite indication that some pure lines of corn will be much more resistant than others. The following comments give an idea of the destructiveness of the disease in part of the corn belt:

Illinois: There is much rotten corn this year mainly due to secondary infections by *Fusarium moniliforme* following the ravages of the corn ear worm and to ear rots caused by *Diplodia zeae*. The season has been unusually favorable for infections by the latter organism. Selections of Reid's Yellow Dent from this locality and from other places in Illinois are showing wide variations in susceptibility to ear rots. (J. R. Holbert. Cereal Courier 13: 241. October 20.)

Iowa, Illinois, and Indiana: After a survey in parts of Iowa, Illinois, and Indiana I have placed the loss of corn from ear rots at 4, 8 and 10%, respectively. *Diplodia zeae* is responsible for about four-fifths of the loss. Various molds following ear worms and mostly restricted to kernels injured thereby or adjacent thereto are responsible for the remainder. (R. O. Cromwell, letter to Dr. G. R. Lyman, Oct. 25, 1921.)

Two abstracts of papers on the parasitism of Diplodia and conditions under which it develops have appeared recently:

Clayton, Edward E. *Diplodia zeae* as an ear and root parasite of corn. (Abstract). Phytopath. 12: 29. Jan. 1922.
Durrell, L. W. Diplodia of corn in Iowa. (Abstract). Phytopath. 12: 29. Jan. 1922.

Leaf spot caused by *Helminthosporium turcicum* Pass.

The leaf spot caused by *Helminthosporium turcicum* was reported only from Connecticut and Minnesota, although it very probably occurs in many states. The injury usually is negligible, and, in fact, is sometimes difficult to detect on account of the presence of other diseases. Clinton states that the disease was much more prevalent than usual in Connecticut and that it began to appear about the middle of August. It caused a certain amount of damage in some fields. In Minnesota the disease caused no appreciable damage although it was fairly prevalent.

Miscellaneous diseases

Leaf blight of sweet corn, probably caused by bacteria. Hungerford observed this disease on Golden Bantam corn in Idaho. It was present only in small gardens in the northern part of the state.

Ear mold caused by Cephalosporium sacchari Butler & Kahn. Manns and Adams called attention for the first time to the parasitism of this organism on corn in the United States. (Manns, T. F. and J. F. Adams. Prevalence and distribution of fungi internal of seed corn. Science n.s. 54: 385-387. Oct. 21. 1921. (No. 1399))

Head smut caused by Sorosporium reilianum (Kuhn) McAlp. The head smut of corn was found in Washington. According to Zundel, in one field near Pullman, 20% of the plants were infected. The disease also was found in Yakima County where considerable corn is grown. Dana states that the disease probably is spreading in Washington. No head smut was observed on corn in California although Mackie is of the opinion that it undoubtedly is present this year as it has been in the past.

Seedling blight caused by Helminthosporium sp. A species of Helminthosporium isolated from living corn plants, according to Stover, was found to cause a marked seedling blight of corn. The results of preliminary experiments are summarized in an abstract presented at the Toronto meeting. (Stover, W. G. The relation of soil temperature to the development of the seedling blight of corn caused by Helminthosporium sp. (Abstract). Phytopath. 12: Jan. 1922.)

RICE

Straighthead (non-parasitic)

Straighthead of rice was reported from South Carolina, Louisiana, Texas, and Arkansas, Fig. 62. Ludwig states that severe local injury probably occurred in South Carolina. Edgerton states that the disease was of considerable importance in Louisiana, although the aggregate loss probably was not very great. Taubenhaus estimates that the yield was reduced by 5% in Texas, and Elliott estimates that the Arkansas yield was reduced by approximately 2%.

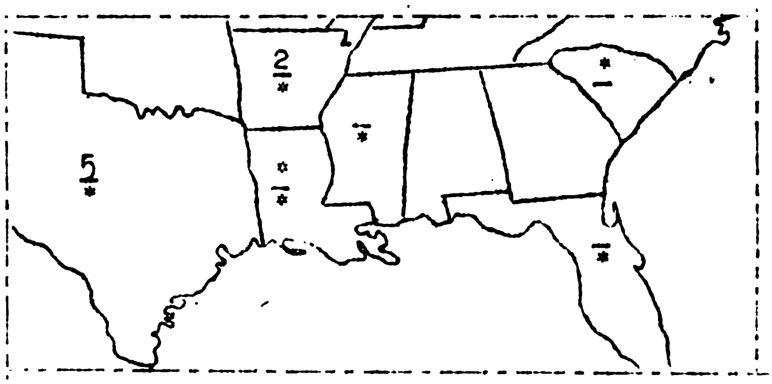

Fig. 62. Occurrence of and percentage loss from straighthead (upper figures) and blast (lower figures) of rice, 1921.

Blast caused by Piricularia oryzae Br. & Cav.

Rice blast was observed during the past year in Florida, Mississippi, Louisiana, Texas, and Arkansas. (See map, Fig. 62, under straighthead.) According to Burger it was reported from Florida, only in Manatee County, where it was said to be doing considerable damage. In Mississippi, according to Neal, it also caused some loss. Edgerton states that it is present throughout the

rice belt of Louisiana, but that it is of very little importance. Taubenhaus states that losses caused by the disease in Texas also were negligible, while Elliott reports a trace of injury in Arkansas.

Miscellaneous diseases

Root rot caused by *Pythium* sp. is reported from Hawaii by C. W. Carpenter. (Carpenter, C. W. Morphological studies of the Pythium-like fungi associated with root rot in Hawaii. Hawaiian Sug. Plant. Assn. Exp. Sta. Bul. 3: 56-65. Aug. 1921.)

Sesame spot caused by *Helminthosporium oryzae* de H. previously reported from Japan, Java, Italy, and the Philippines, was observed by W. H. Tisdale in Louisiana during 1920, according to G. O. Ocfemia. This fungus is said to be identical with *Piricularia oryzae* Br. & Cav. (Ocfemia, G. O. The sesame spot disease of rice (Abstract). Phytopath. 12: 34. Jan. 1922.

Recent literature

Farneti, R. Sopra il "brusone" del riso: note postume. Atti Ist. Bot. Univ. Pavia bv. 18. 14. p. pl. 20-21. 1921.

Nishikado, Yoshikazu and Giichi Miyake. Momidane no shodoku narabini ine gomahagarebyo no yoboho (Disinfection of seed rice in relation to the prevention of Helminthosporium rice blight). (2) Ryusando ni yoru shodokuho (Disinfection by means of copper sulphate) Byochu-gai Zasshi (Jour. Plant. Prot.) 8: 498-506. Oct. 1921.)

Sundaraman, S. Helminthosporium disease on "rice" (*Oryza sativa*). Yearbk. Madras Agr. Dept. 1920/21: 111-114. 1921.

Tisdale, W. H. Two Sclerotium diseases of rice. Jour. Agr. Res. 21: 649-657. pl. 122-126. Aug. 1, 1921. (Aug. 26).

FLAX

Wilt caused by *Fusarium lini* Bolley

Flax wilt was found in Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota. Coons states that it was reported to be destructive in the fiber flax district in the "Thumb" of Michigan, although no definite figures on losses are available. In Wisconsin, according to Vaughan, at least one field in Kewaunee County was affected, but, since flax is not extensively grown in Wisconsin, the disease was not widespread. In Minnesota the disease was generally distributed, particularly on late planted flax. The injury ranged from a trace to 75%. The reduction in yield for the entire state is estimated at 7.5%. Brinsmade states that the flax wilt developed rapidly in North Dakota during the hot weather in June. He comments further, on July 20, that the combination of drought and heat was likely to ruin all the flax except that grown in cultivated nursery rows. (Cereal Courier 13: 142. July 20, 1921.) Bolley makes the following comment on conditions in North Dakota:

> "The wilt diseases as usual have been rather evenly distributed, particularly in the eastern half of the state

> on the old lands and have done damage in direct ratio to the plantings made on old lands. Most areas of wilt destruction were found upon lands already infested. Control has been quite evident on all those fields where proper wilt resistant stuff has been planted."

Evans states that the disease is general on old land in South Dakota. Jennison observed none of the disease in Montana, but he is of the opinion that some undoubtedly was present.

Flax wilt can be controlled easily by using resistant varieties. Several such varieties have been used in North Dakota for many years. At the Minnesota Station also resistant strains have been developed. The resistance is not absolute, and, if resistant flax is grown under conditions favorable for the fungus and unfavorable for the host, considerable wilt may develop.

Recent literature

Pethybridge, Geo. H., H. A. Lafferty, and J. G. Rhynehart. Investigations of flax diseases (second report). Jour. Dept. Agr. and Tech. Instr. Ireland 21: 167-187. April 1921.

Tochinai, Yoshihiko. Studies on the physiology of Fusarium lini. Trans. Sapporo Nat. His. Soc. 8: 19-44. 1921.

Rust caused by Melampsora lini Pers. (Desm.)

Flax rust was found only in the following states: Michigan, Wisconsin, Minnesota, and North Dakota. According to Coons, the disease probably was reported for the first time this year from Michigan. In Wisconsin it was reported only from Wood County while in Minnesota it was quite generally distributed, although it did practically no damage. According to Brentzel considerable rust developed on flax in North Dakota during August. "Most of the varieties and selections show some rust infection but some of the early maturing varieties developed with practically no rust." (Brentzel, W. E. Cereal Courier 13: 201. Sept. 10, 1921.) Bolley states that in some fields wilt resistant flax suffered badly from rust. In Minnesota the disease has rarely been of economic importance, probably on account of the fact that the variety of flax most commonly grown, Primost, Minnesota 25, is quite resistant to the disease.

Recent literature

Pethybridge, et al. (see under wilt).

Canker (non-parasitic)

The non-parasitic canker of flax was observed in South Dakota, but the injury was very slight, according to Evans. It occurred also in North Dakota where it was severe in some fields, according to Bolley and Brentzel, although it was less prevalent than it was last year and also less prevalent than it is in an average year. The maximum percentage found in any one field in North Dakota was 25, and the disease first appeared on June 10. In Minnesota the disease was found first in Polk County. It had not previously been observed, although it probably occurred. In one field 10% of the plants were killed.

Anthracnose caused by Colletotrichum lini Bolley

Anthracnose was not observed in any of the principal flax-growing states (Montana, North Dakota, Minnesota, Wisconsin, and Michigan), except in Michigan. Coons reported its occurrence at the Michigan Agricultural College.

Miscellaneous diseases

The following diseases of flax are described by Pethybridge, Lafferty, and Rhynehart (l.c.; see under wilt) as occurring in Ireland: seedling blight caused by Colletotrichum linicolum P. & L., foot-rot caused by Phoma sp., browning and stem-break caused by Polyspora lini n. gen. et sp., Sclerotium disease caused by Sclerotinia sclerotiorum, yellowing (non-parasitic), and Botrytis disease caused by Botrytis sp. These have not been reported for the United States.

Reference

Lafferty, H. A. The "browning" and "stem-break" disease of cultivated flax (Linum usitatissimum) caused by Polyspora lini n. gen. et sp. Sci. Proc. Roy. Dublin Soc. n.s. 16: 248-274. Aug. 1921.

SORGHUM

Covered kernel smut caused by Sphacelotheca sorghi (Link) Clinton

Reported from New York; according to Chupp, one or two individual farmers reported that it was rather prevalent. Present in Alabama, 20% in experiment station plats according to Povah. Texas, 1% loss; Wisconsin, of minor importance, seed from south and southwest most heavily infected; seemed to be resistant strains of amber sorghum; no apparent injury to syrup production - Vaughan. In Kansas common in western and central regions, although it occurs in every county where sorghums are grown. Seed treatments gave almost perfect control - Stokdyk.

Loose kernel smut caused by Sphacelotheca cruenta (Kühn) Potter

The loose smut was reported only from Texas. Taubenhaus estimated that the reduction in yield due to the disease was approximately 2%. Kulkarni states that dwarf milo sorghum is resistant although not immune to grain smut, but that it is decidedly susceptible to loose smut. (Kulkarni, G. S. The susceptibility of dwarf milo sorghum to smut. Phytopath. 11: 252. June 1921 (Oct.)).

Head smut caused by Sorosporium reilianum (Kühn) McAlp.

Head smut was reported only from Wisconsin, Minnesota, and Kansas. In none of these states did it cause serious losses, although sometimes it does

considerable damage. This year there was a considerable amount of it in some seed plots in Minnesota. The following statement summarizes the situation in Minnesota.

> Ordinarily, smut is not a limiting factor in the sorghum syrup industry, but occasionally serious epidemics affect the color of the syrup (turning it an undesirable pink) and produce clouds of spores in the mills. This spore dust contaminates the syrup and becomes a general nuisance in the mill. Such an epidemic occurred in 1918. "Smut does not lower the sugar content of individual sorghum plants but its effect on yield per acre is unknown."
>
> In 1921 infection was not general around Waconia, eighty percent of the fields being free from smut. In Willaman's seed plot, however, about seventy percent of the plants, all Minnesota Early Amber, were infected. The strains in this field had been selfed for two years, and as sorghum is normally only about eight percent cross fertilized, some of these strains were nearly pure lines.
>
> One strain, noted especially, comprising a fraction of a row, was completely free from smut, while the remainder of the row, and the two adjacent rows were so heavily infected that it would have been difficult to find a single clean hill in them. Seed from this apparently resistant strain, selfed for three years, is available for next year. (Willaman and Lambert).

Blight caused by *Bacillus sorghi* Burr.

Blight caused by *Bacillus sorghi* was found only in Delaware and Wisconsin. Collaborators in both states report that it was relatively unimportant.

DISEASES OF FORAGE CROPS

A. LEGUMES

ALFALFA

Leaf spot caused by *Pseudopeziza medicaginis* (Lib.) Sacc.

The Pseudopeziza leaf spot is widespread. It is reported from many states, as will be seen from the map, Fig. 64. It is quite likely that this leaf spot disease causes more damage than is sometimes supposed, although it is always difficult to estimate the reduction in yield caused by such a disease.

Vaughan observes that in Wisconsin the disease is worst on acid soils. Stokdyk states that the spot was severe in Kansas in fields which were not cut early. In Arizona, according to Brown, the disease is fairly well distributed but not very important. In Idaho, it is common wherever alfalfa is grown, according to Hungerford. Barss says that the disease is common, but not often serious, in Oregon. Mackie notes that in California the first crop sustains the greatest damage and that the succeeding crops are injured but little.

Yellow leaf blotch caused by Pyrenopeziza medicaginis Fokl.

The states from which the yellow leaf blotch was reported, together with estimates of injury, are indicated on the map, Fig. 63. While the disease was widespread, it apparently was not very injurious during the past season, except in Idaho. Hungerford states that it causes defoliation of plants, is common throughout the state, and that it is the most serious disease on alfalfa in Idaho. According to Hungerford, the first cutting is most severely injured. In Oregon, it is said to be most common in the semi-arid regions of the state.

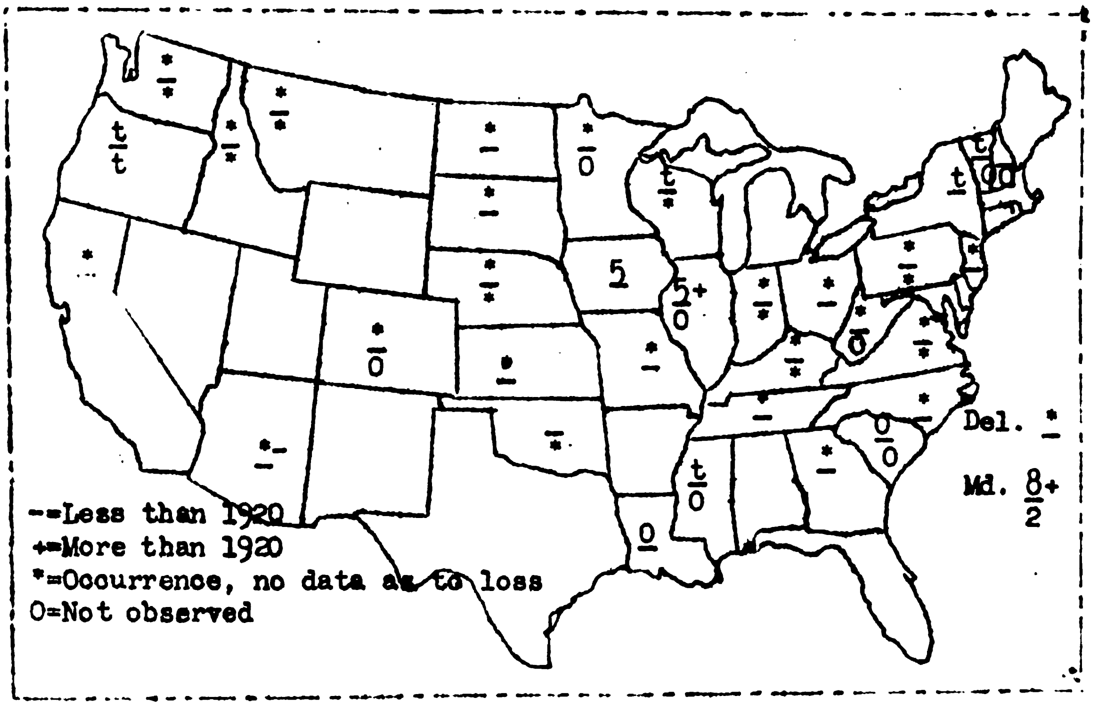

Fig. 63. Occurrence of and percentage losses from Pseudopeziza medicaginis (above line) and Pyrenopeziza medicaginis (below line) in 1921.

Rust caused by Uromyces medicaginis Pass.

Rust was reported from several states although it apparently did little damage in any of them. In North Carolina it was unimportant and occurred mostly in the Piedmont and Mountain counties; in Mississippi it was unimportant and occurred locally; in Louisiana the importance was considerable, according to Edgerton; in Texas there was a slight trace in the Rio Grande Valley. It

occurred also in Ohio, Indiana, Wisconsin, North Dakota, and Kansas. In Arizona, according to Brown, it was generally distributed but not important. The greatest aggregate damage apparently was done in California, where Mackie estimates a reduction in yield of 1%.

Anthracnose caused by Colletotrichum trifolii Bain

Anthracnose was reported from Arkansas and Mississippi as follows:

Arkansas: The disease was much worse than last year and also much worse than in an average year; 100% of the plantings in the state were infested and 95% of the plants were affected. There was continuous girdling of the shoots until the crowns and roots rotted. The host was affected in all stages of growth. The spring was very wet and the temperature was slightly above normal. Many fields were plowed and practically no hay was cut as the disase continued to kill the plants throughout the summer. A little hay was cut early. (Crawford and Elliott).

Mississippi: I have just received specimens of alfalfa from Sharkey County which are infected with anthracnose, Colletotrichum trifolii. This is of interest since Professor Beal says this is the first time to his knowledge that anthracnose of alfalfa has ever been reported from Mississippi. It is reported as causing considerable loss in a field of several acres at Anguilla, Sharkey County. (Neal).

Bacterial blight caused by Bacterium medioaginis Sackett

Bacterial blight was reported from Wisconsin (less severe than usual); Montana (about the same as usual); Colorado (unimportant); Arizona (less than usual, a few fields fairly badly injured); Utah (some damage); Idaho (more than usual, especially in southern irrigated sections); Washington (Whitman County); and Oregon (probably not very important).

Downy mildew caused by Peronospora trifoliorum de Bary

Downy mildew was reported from Virginia (slight damage in field at Blacksburg); Louisiana (little importance); Illinois (one field); Wisconsin; Kansas; Montana, Colorado; Idaho (due to wet spring, more prevalent than ever before); Arizona (trace); Washington; and Oregon (probably worse than usual, due to moist and mild winter and cool spring, not of great importance though coextensive with host). In none of these states was the aggregate damage great. Undoubtedly the disease occurred also in other states but it probably was not noticed on account of its relative inconspicuousness.

Root rot caused by Sclerotinia trifoliorum Eriks.

Slight damage was caused in Virginia. At Blacksburg from 2 to 3% of the plants were affected. In Kentucky apparently there was more than usual, particu-

larly on young plants. Valleau suggests that the open warm winter was favorable to the disease. In North Carolina it was most prevalent in the Piedmont counties. There was a trace of damage in Mississippi, in Arkansas, Wisconsin, North Dakota (one case only), two reports from Idaho, one from Bonners Ferry and the other from American Falls (first report of the disease from Idaho). In Washington it occurred in the Puget Sound region. In Oregon, according to Barss, it was worse than usual, and serious in many fields, occurring throughout the western part of the state. The following comments are made by various collaborators:

North Carolina: Sclerotinia wilt is destructive to alfalfa. Estimates of loss in individual instances have been noted and Sclerotinia wilt has frequently caused the grower to abandon the growing of clover and alfalfa. A field of clover and alfalfa in Durham County was so badly infested with Sclerotinia wilt that it was planted to other crops. (A. C. Foster).

South Dakota: A year or so ago a very serious crown rot appeared in the alfalfa and sweet clover during the late spring. Whether this was due to Sclerotinia trifoliorum or not I am unable to say. I have made examination for it this year but have found no trace of it. (Evans).

Root rot caused by Ozonium omnivorum Shear

This was reported from Texas in which Taubenhaus states that it is so important as to prevent the growing of alfalfa in the heavy clay soils of the state. The only other state from which the disease was reported is Arizona. Brown states that it occurs in all alfalfa districts and that it can be detected throughout the year.

Miscellaneous diseases

Leaf spot caused by Cercospora medicaginis E. & E. - Slight traces reported from Texas.

White spot, cause unknown - reported from Casa Grande district in Arizona, and from Spokane County, Washington.

Yellow top - reported from southeastern Washington.

Violet root rot caused by Rhizoctonia medicaginis (DC.) Tul. - reported from Iowa.

Root rot, cause unknown - Hungerford reports the general presence in Idaho of a root and crown rot which appeared to be particularly severe on account of the cold, wet spring.

Root knot caused by Heterodera radicicola (Greef.) Müll. - reported from Texas, where, according to Taubenhaus, it was unimportant. Taubenhaus notes that the Hairy Peruvian variety is quite resistant and that it saved the crop in Webb County.

Tylenchus dipsaci (Kühn) Bastian - reported from Oregon by Barss who says that it caused considerable injury in at least one field on the campus at Corvallis. This is the first report of the disease on alfalfa in Oregon. According to Godfrey it occurs on this host in Idaho also.

Dodder (Cuscuta spp.) - reported only by Gardner from Indiana, but it

undoubtedly occurs in other states also.

Frost injury - reported as having been severe in Pennsylvania and Michigan. Coons states that Grimm and Cossack varieties were not wounded.

CLOVER

(White clover, Trifolium repens; red clover, T. pratense; alsike clover, T. hybridum; crimson clover, T. incarnatum)

Anthracnose caused by Colletotrichum trifolii Bain

Anthracnose was observed in the following states: Delaware - (unimportant); Kentucky (caused the death of plants in a considerable number of fields, large amount in some fields, caused a stem blight on crimson clover before blossoming time, and occurred also on young red clover; effect was aggravated by dry weather); Virginia (Concerning specimens collected at Arlington Farm by R. J. Haskell - I have received the specimen of clover anthracnose which you sent me a few days ago. This anthracnose is probably the same one that occurs upon clover in the Tennessee region and is not the one caused by the fungus, Gloeosporium caulivorum. The fungus on the specimens which you sent me is the Glomerella type.- Edgerton); Tennessee (on red clover, important but no definite figures on losses); North Carolina (not destructive); Ohio (importance slight, worse in the western portion of the state, infection most conspicuous and injurious on second growth crops - Young); Indiana (probably important); Illinois (red clover situation is average, disease has played an important part in clover failure, anthracnose being the most serious in my opinion - I do not have any information as to the losses that clover diseases may have caused - Dungan); and Wisconsin (minor importance).

Anthracnose caused by Gloeosporium caulivorum Kirch.

Anthracnose was reported as follows: Connecticut (Sheldon): I found the first that I have ever seen here May 4. Pennsylvania (Orton): Anthracnose is usually present in most fields of red clover and it is not uncommon to find it killing the stems of 5% of the plants. Ohio: Observed June 9, western Ohio, general but not serious in western and southwestern Ohio.

Leaf spot caused by Pseudopeziza trifolii (Bernh.) Fckl.

Leaf spot was reported from Vermont, New York, Pennsylvania, Delaware, Virginia, West Virginia, Kentucky, Ohio, Illinois, Michigan, Wisconsin, South Dakota, Washington, Oregon, and California, but it was of no particular importance in any of these states.

Powdery mildew caused by Erysiphe polygoni DC.

One of the noteworthy pathological features of the year was the unusual prevalence of clover powdery mildew. It was reported from the following states: New Hampshire (no material damage); Connecticut (reported for the first

time, inconspicuous and ascigerous stage not produced - Clinton); New York (very prevalent, made nearly every clover field in the state white; Seneca County, affected plants only half the size of the healthy ones; Suffolk County, quite common in red clover fields about Mattituck; and Sullivan County, general over county, severe - Chupp); New Jersey (abundant); Pennsylvania (general, but apparently doing little damage); District of Columbia; Delaware (general and important); Maryland (much worse than usual, particularly on second crop of red clover, estimated by Temple and Jehle to have reduced the yield of the late crop by 5% and to have reduced the entire crop of the state by 2%); Virginia (much more prevalent and probably quite destructive, most prevalent in south central part; more questions and complaints this year than all my previous six years in the state - Fromme); West Virginia (unimportant and occurring locally); Kentucky (more prevalent than usual, found practically in all fields examined, red and mammoth clover affected, crimson clover, alfalfa, sweet clover, Jap clover, trefoil, and spring vetch not affected, although in close proximity to red and mammoth clover - Valleau); Ohio (very much more prevalent than before although apparently not reducing in yield); Indiana (unusually prevalent, co-extensive with the host); Michigan (first appeared as common disease in 1921 - Coons); Wisconsin (less prevalent than usual, and unimportant); and Washington (observed in Whitman County).

Rusts caused by *Uromyces fallens* (Desm.) Kern and *U. trifolii* (Hedw. f.) Lev.

According to Arthur (N. Am. Fl. 7[3]: 254-255. 1912) *Uromyces fallens* occurs on red and crimson clover, while *U. trifolii* attacks alsike, crimson, and white clover. The distribution of the two species in North America is given as follows:

> *U. fallens*: "On the subgenus *Lagopus* throughout the eastern United States and Canada from the Great Plains to the Atlantic Coast, and in one locality in the Selkirk Mountains (British Columbia)."
>
> *U. trifolii*: "On the subgenus *Trifoliastrum* chiefly, from Newfoundland to Washington southward to the West Indies and central Mexico, rare in the southeastern states and on the Pacific Coast."

In 1921 most states reported only *U. fallens* without mentioning the kind of clover. According to E. B. Mains, however, *U. trifolii* occurred on white clover in northern Indiana, and Melhus reported this species on clover in Iowa. In both states it was apparently unimportant.

U. fallens was reported from Vermont, Connecticut, Pennsylvania, Delaware, Maryland, West Virginia, Kentucky, North Carolina (reported as *U. trifolii* on red clover), Louisiana, Arkansas, Ohio, Indiana (on crimson clover), Michigan, Wisconsin, Minnesota, North Dakota, Nebraska, Washington, and California. It was not said to be important, although rather generally distributed in many states, except in North Carolina, where Foster says that it is common and quite destructive, especially on red clover. In Indiana, according to Mains, "Italian seed produced resistant plants but they winterkilled badly.

Root rot caused by Sclerotinia trifoliorum Eriks

The Sclerotinia root rot was observed in Maryland (1% reduction in yield; 5% loss for crimson clover which is particularly susceptible - Temple and Jehle); Kentucky (apparently not serious on red clover but very injurious on crimson clover, alfalfa, and, during the past year, on sweet clover; aggregate damage slight - Valleau); Tennessee (important on red clover); North Carolina (3% loss (see also quotation below); Mississippi (trace); Wisconsin; and Oregon (worse; in general of minor importance, causing only slight reduction in yield. Occurs generally in western Oregon. Caused considerable damage locally. Bad on alsike clover; one case of damage to white clover in lawn reported - Barss).

The following report by A. C. Foster concerning the importance of the disease in North Carolina is of interest:

> "I should say that by far the most destructive disease of both red and crimson clover is that of Sclerotinia wilt, this being reported from nearly every section of the state where clover is grown.
>
> "Estimates of loss in individual cases have been noted and Sclerotinia wilt has frequently caused the grower to abandon the growing of clover and alfalfa. On the Station farm near West Raleigh, there is one such field, which was cropped to clover continually for several years until the wilt caused its death every year and the growth of clover was discontinued. In another instance a field of clover and alfalfa in Durham County was so badly infested with Sclerotinia wilt that it was planted to other crops."

Root rot caused by Fusarium sp.

Ohio: In the Plant Disease Survey reports we have a card for 1909 and 1910 referring to root rot of alfalfa caused by Fusarium roseum. About this time I find a reference to a stem blight of red clover due to F. roseum. (See also Ohio Bulletin 214, page 390, on red clover, and page 368 for root rot of alfalfa).

In Ohio Bulletin 203 the following statements were made:

> "Infection experiments in the greenhouse (Pathologium) by use of cultures of Fusarium roseum Lk. from wheat, of Gibberella saubinetii (Mont.) Sacc. and of Fusarium roseum from clover, as well as sterilized dead scab kernels, showed a high death rate in the seedlings as a result of the infection. Infections by use of a mold fungus, Periconia pyonospora, gave about the same result as in the check portions.
>
> "This infection work together with field work and cultures from clover stems indicate that Fusarium roseum Lk. is an active parasite upon red clover (Trifolium pratense L.) and is a cause of clover sickness in clover fields seeded after wheat. Evidence is also found in its parasitism upon alfalfa resulting in possible sickness."

We have certainly a marked outbreak of the trouble in Ohio for 1920 and 1921, and we are hoping to be provided with the necessary means for pushing our investigation of possible inter-relations in Fusarium diseases of cereals and forage plants. (A. D. Selby).

Very serious on T. medium, but other clovers not so much injured. Possibly same fungus as causes wheat scab and corn root rot. Some confusion with this trouble and injury from root borer. (M. J. Young).

Indiana: Root rot caused probably by a Fusarium severe in certain fields. (Gardner).

Wisconsin: A wilt of clover caused apparently by a Fusarium was found at Madison this summer. Damage from this source was slight. (Letter from Mr. Fred R. Jones, Dec. 8).

Root rots (causes undetermined)

The following comments on root rots are interesting:

Louisiana: The red clover is not a very important crop in Louisiana, due to the fact that it has to be grown as an annual. It dies out during the hot summer months. How much of this dying out is due to various root rots has never been determined. There is reason to suspect that Rhizoctonia and possibly other fungi have something to do with this. (Edgerton).

Ohio: Root rot has been reported as causing severe loss in that part of Ohio immediately to the southeast of Columbus. The men state that whole fields have died out, the trouble being most noticed at cutting time and after. Plants affected have the roots rotted entirely away.

Control measures have not been worked out, but it has been observed that mammoth and alsike clover are much less affected than is red clover. (Clayton).

Idaho: Rotting of the crown and roots. Reported from various parts of state in both irrigated and non-irrigated sections. (Hungerford).

Weather injury

According to the Market Reporter 4: 161, September 10, the extremely hot dry weather following the first cutting of the hay crop caused a considerable amount of injury, and the late spring freezes did some damage in central Illinois, northern and central Wisconsin, central Minnesota, northern Ohio, and northern Missouri. In Pennsylvania, according to Orton, crimson clover and red clover suffered severely from frost injury. Attention is called by collaborators in North Carolina and Maryland also to the injury done clover by the mild winter and the spring freezes. The following notes from Pennsylvania, concerning frost injury, and from Kentucky regarding winter injury, are of interest:

Pennsylvania: The red clover crop has generally been a failure in Pennsylvania this year. Thousands of acres were frozen during the early freeze which also hit the fruit crop severely.

This is the first time in my connection with Pennsylvania (nine years) that red clover has been seriously damaged by frost. It is quite evident that the weather in April brought the clover along too rapidly and made it susceptible to the freezes in May. So far as we can determine diseases did not play any important part in this year's loss to this crop. White clover is hardy. (Orton).

Kentucky: It is evident from the work of Professor Roberts of this Station who has done an immense amount of work in soil fertility in its relation to clover production, that the production of clover in this state is nearly entirely dependent upon the proper handling of the soil, and it would not be surprising if a similar situation were found throughout a considerable portion of the middle eastern states. The effect of lime and acid phosphate in the production of high yields of clover is very striking. I have gone over some of the fields and there is apparently little difficulty from the standpoint of disease in getting a good stand of clover. The principal trouble in this state from clover losses seems to be the inability of clover planted on certain soils being able to come through the winter alive. The soils which are untreated apparently heave the young clover plants out of the ground much more easily than in the treated soils. This is probably due to the fact that on the treated soils the root system is very much better developed than on the untreated portions, and in consequence, is not so readily disturbed. (Valleau).

Miscellaneous diseases

Leaf spot caused by Cercospora medicaginis E. & E. - observed in Delaware (for the first time) and in Indiana. Apparently it was not very destructive.

Leaf spot caused by Cercospora zebrina Pers. Bessey states that this was the most common leaf spot of red clover in Alpena County, Michigan.

Sooty spot caused by Phyllachora trifolii (Pers.) Fckl. - reported from Pennsylvania (common but not destructive); Virginia (very destructive in a few fields, especially on crimson clover); and North Carolina (one of the most common leaf spots and quite destructive to red clover).

Large leaf spot caused by Macrosporium sarciniforme Cav. - reported from Pennsylvania, Louisiana, Arkansas, and Ohio. According to Orton, it is prevalent but not destructive in Pennsylvania. Edgerton is of the opinion that this leaf spot may be the most common and most destructive one in Louisiana, where it sometimes causes severe defoliation. According to Elliott, it is relatively unimportant in Arkansas. According to Young, this is the first report in Ohio. The disease unquestionably occurs in other states also.

Mosaic (cause undetermined) - reported from Pennsylvania (on red clover but not on white), Illinois, Wisconsin. Apparently it was also prevalent in Quebec, Canada, according to Dickson and McRostie. (Dickson, B. T. Further studies on mosaic -I. (Abstract). Phytopath 12: 42. Jan. 1922. Dickson, B. T. and G. P. McRostie. Further studies on mosaic -II. (Abstract). Phytopath. 12: 42. Jan. 1922.)

Wilt caused by Sclerotium sp. Foster states that occasionally Sclerotium wilt is reported on clover in North Carolina.

Slime mold (Physarum cinereum (Batsch.) Pers.) - reported by Young from Ohio, damage negligible.

Nematode disease caused by Tylenchus dipsaci (Kühn) Bastian. Hungerford reports that this disease is very important in the Twin Falls section of southern Idaho. It was reported also from Coos County, Oregon. Barss says that it is not important, but that it may be more widely distributed in the state than is known at present. (See Godfrey, G. H. The stem and bulb infesting nematode in America. (Abstract). Phytopath. 12: 52-53. Jan. 1922, and Goodney, T. On the susceptibility of clover and some other legumes to stem diseases caused by the eelworm, Tylenchus dipsaci, syn. devastatrix, Kühn. Jour. Agr. Sci. 12: 20-30. Feb. 1922.)

Dodder (Cuscuta spp.) - reported from Indiana.

SWEET CLOVER (Melilotus spp.)

Damping off of young shoots caused by Corticium vagum solani Burt - Michigan.

Ascochyta stem canker caused by Ascochyta caulicola Laub. - causes blasting of seed in seed fields - Michigan. (Coons).

Mosaic (cause undetermined) - reported from New York, Pennsylvania, Indiana, Quebec (Dickson, l.c., see clover mosaic).

Anthracnose, probably caused by several fungi - Louisiana.

Crown rot and wilt, caused by Sclerotinia trifoliorum Eriks. - reported by Valleau to be injurious in Kentucky; and by Barss as bad in western Oregon.

Frost injury - reported by Heald and Dana from Washington.

MEDICAGO Spp.

Smut caused by Entyloma meliloti McAlp. on Medicago (Indica ?). The following excerpt is taken from a letter written by Fred. R. Jones. "Entyloma meliloti was found in Alabama in the latter part of March this year. The specimen was determined by Dr. J. J. Davis and is the first specimen of this fungus in the country of which we can find record."

Mosaic on Medicago lupulina. See Dickson, B. T. Further studies on mosaic -I (Abstract). Phytopath. 12: 42. Jan. 1922.

Anthracnose - Louisiana: The anthracnoses are not common. The legume anthracnoses need working over. There are a number of these forms which to me seem different. They occur on Melilotus and bur clover and may go to the red clover where this plant is grown on any scale. (Edgerton).

Leaf spot caused by Cercospora medicaginis E. & E. One record of occurrence in York County, South Carolina. Found in garden patch - unimportant. (Ludwig). The following report from Alabama is interesting:

> The organism causing the leaf spot of bur clover is seed-borne. Dr. Hopkins, experimenting with various methods, found that by using hulled seeds he secured 100% healthy plants when the diseased seed were treated with 40% formaldehyde for 2 hours or with a 1:1000 mercuric chloride solution. Treated seeds were inoculated again after treatments. By treating the seed with hulls attached no satisfactory results were obtained. Dr. Hopkins' results will be published soon. (Thiel).

Powdery mildew caused by Erysiphe polygoni DC. - reported from Mississippi where it was unimportant but general in the eastern and northern counties, according to Neal and Miles.

COWPEA

Leafspot caused by Cercospora cruenta Sacc. - reported from Delaware (prevalent on older and lower leaves; first report for the state - Adams); Virginia (very severe damage reported from a field at Bowling Green - Fromme); Texas (prevalent, reducing the yield by approximately .5% - Taubenhaus); Arkansas (general and reducing yield by a trace); and Indiana (rare).

Leafspot caused by Amerosporium oeconomicum E. & T. - Delaware.

Leaf blight caused by Macrosporium sp. - Arizona.

Powdery mildew caused by Erysiphe polygoni DC. - The Oidium stage was found in June by Burger in Florida. The disease was observed by Gardner in a greenhouse in Indiana. Only the conidial stage was present.

Rust, caused by Uromyces appendiculatus (Pers.) Lev. - Virginia (blackeye is the only susceptible variety grown commercially in the state - Fromme); Texas (prevalent on fall plantings; caused a reduction of 1% in yield - Taubenhaus).

Mosaic (cause undetermined) - Arkansas.

Wilt caused by Fusarium vasinfectum Atk. - Virginia (severe damage; 20% in one field near Petersburg); South Carolina (prevalent and important. One kind affected was the garden variety, "Black-eyed pea". This is typically a sandy soil disease but during the last few years seems to be invading the Piedmont - Ludwig); Arkansas (scattered, but severe in some places; 2% reduction in yield - Elliott).

Root rot caused by Ozonium omnivorum Shear - Texas (8% reduction in yield - Taubenhaus).

Rhizoctonia blight said to be due to Rhizoctonia dimorpha - reported by Matz from Porto Rico.

Root rot, cause unknown - reported by Ludwig from South Carolina.

Root knot caused by Heterodera radicicola (Greef) Müll. - South Carolina (present in the northwestern portion of the state; typically sandy soil disease which seems to be becoming more important in the Piedmont - Ludwig); Arkansas (general; reduced yield of state by 10% - Elliott).

Sunscorch - reported by Adams from Delaware.

SOYBEAN

Bacterial blight caused by Bacterium glycineum Coerper and B. sojae Wolf - reported from Armstrong County, Pennsylvania; from the coastal plain region of North Carolina in which it was more prevalent than previously; from South Carolina where the reduction in yield was 1%; and from Louisiana, Indiana, and Michigan. (Shunk, I. V. and F. A. Wolf. Further studies on bacterial blight of soybean. Phytopath. 11: 18-24. Jan. 1921. (Feb.).)

Bacterial spot caused by Bacterium sp. - (Takimoto, Seito. Daidzu no saikinsei hantenbyo (Bacterial spotting diseases of soybean.) Byochu gai zasshi (Jour. Plant Prot.) 8: 237-241. May 1921.) Caused by a new bacterium not identical with B. glycineum, B. sojae, or Pseudomonas glycineum Nakano.

Sclerotium wilt caused by Sclerotium rolfsii Sacc. - reported from North Carolina where Foster states that it is important on the coastal plain, and from Louisiana where Edgerton estimates a reduction in yield for the state of from 1 to 2%.

Wilts caused by Verticillium sp. (possibly) and Fusarium sp., - according to Foster occur particularly in the Coastal Plain of North Carolina. There are striking differences in varietal resistance to Fusarium but not to Verticillium.

Mosaic (cause undetermined) - reported from North Carolina and Indiana. (Gardner, M. W. Soybean mosaic. Jour. Agr. Res. 32: 111-113. pl. 18-19. Oct. 8, 1921.)

Leaf spot, probably caused by a species of Macrosporium - reported by Gardner from Indiana where it appeared late in the season on Black Eyebrow, Dunfield and Ito San varieties.

VETCH

Leaf spot caused by Ascochyta pisi Lib. - reported from Delaware (first report in state).

Rhizoctonia root rot - reported from Washington.

HORSE BEAN (*Vicia faba*)

Mosaic (cause undetermined) - "Haricots (*Vicia faba*) suffered as much as 50% damage from mosaic in Quebec." (Dickson, B. T. Maladies des plantes en 1920-21. Ann. Rep. Quebec. Soc. Prot. Plants 13 (1920-21); 66-67. 1921.)

GUAR (*Cyamopsis tetragonoloba* Taub.)

Southern blight caused by *Sclerotium rolfsii* Sacc. - found in light sandy soils only (in Texas) causing a reduction in yield of 1%. (Taubenhaus).

B. GRASSES

Brown patch disease caused by *Rhizoctonia solani* Kühn

The brown patch disease, which was reported in September 1 issue of the Plant Disease Bulletin is sometimes injurious on lawns in Connecticut, according to Clinton, and appeared in New York also, where Chupp says that it is quite troublesome on golf courses.

Literature

Piper, C. V. and R. A. Oakley. The brown patch disease of turf. Bul. Green. Sect. U. S. Golf Assoc. 1: 112-115. June 1921.

Plant Disease Survey. Brown patch of turf caused by *Rhizoctonia solani* Pl. Dis. Bul. 5: 76. Sept. 1, 1921.

TIMOTHY

Rust caused by *Puccinia phlei-pratensis* Eriks. & Henn.

Timothy rust occurs practically throughout the United States, but it was apparently not very prevalent this year. It was reported from New York, South Carolina, Tennessee, Indiana, Minnesota, Iowa, Missouri, and North Dakota. The disease was said to be unimportant in New York and South Carolina, and to be less prevalent in Minnesota than for several years. H. D. Barker, who has been

studying the rust for several years, comments as follows on its occurrence in 1921:

> "In general I might say that timothy rust, at least late in the summer, was very hard to find throughout Iowa, Illinois, and Indiana. I made several examinations of timothy fields while we were on our trip South and found timothy rust very scarce indeed. I do not know what the cause for this was, except possibly the dry summer or peculiar overwintering conditions last winter, but the fact remains that timothy rust seemed scarcer than usual during the past summer."

Smut caused by Ustilago striaeformis (West.) Niess.

Timothy smut was reported only from New York, where the disease was found locally on a private lawn, according to Kirby; and from Iowa and Minnesota where it apparently was fairly general but unimportant.

MILLET (Panicum miliaceum)

Head smut caused by Ustilago panici-miliacei (Pers.) Wint. - reported from Washington by Heald and Dana.

SUDAN GRASS (Holcus sorghum sudanensis (Piper) Hitchc.)

Anthracnose caused by Colletotrichum cereale Manns - reported from North Dakota. Severe on two large fields in which it occurred in connection with Bacillus sorghi. It was much more abundant than the bacterial leaf blight - Wanda Weniger.

Bacterial blight caused by Bacillus sorghi Burr. - South Carolina, North Dakota, and Washington.

Leaf spot caused by Phoma insidiosa Tass. - Arlington Farm, Virginia, Sept. 1920. (Koch, Elizabeth and Caroline Rumbold. Phytopath. 11: 345. Aug. 1921.

Smut caused by Sphacelotheca sp. - Washington.

MISCELLANEOUS GRASSES

The following organisms were reported on miscellaneous grasses as follows:

Claviceps purpurea
- Agrostis alba - Wisconsin
- Calamagrostis canadensis - Minnesota

Erysiphe graminis
- Poa pratensis - South Carolina, Minnesota, Washington
- Hordeum jubatum - Minnesota

Helminthosporium sp.
- Agropyron caninum-Minnesota (Christensen)
- Agropyron intermedium " "
- Agropyron repens " "
- Agropyron smithii " "
- Agropyron tenerum " "
- Alopecurus pratensis " "
- Andropogon furcatus " "
- Calamagrostis canadensis " "
- Chaetochloa italica " "
- Dactylis glomerata " "
- Digitaria sanguinalis " "
- Echinochloa crusgalli " "
- Elymus canadensis " "
- Elymus striatus " "
- Elymus virginicus " "
- Festuca elatior (Drechsler, Charles-Net blotch of meadow fescue caused by an undescribed species of Helminthosporium. (Abstract). Phytopath. 12: Jan. 1922.
- Hierochloë odorata-Minnesota (Christensen)
- Hordeum jubatum-Minnesota (Christensen)
- Muhlenbergia sp. " "
- Panicum capillare " "
- Phalaris arundinacea" "
- Phragmites phragmites " "
- Poa pratensis-Illinois, Minnesota
- Setaria glauca-Minnesota (Christensen)
- Sorghum halapense " "
- Stipa spartea " "
- Zizania palustris - Minnesota

Helminthosporium bromi
- Bromus inermis - Minnesota

Ophiobolus sp.
- Agropyron repens-New York(field; Kirby)
- Bromus secalinus-Arkansas (Rosen)
- Elymus spp.-New York(artificial inoculation; Kirby)
- Festuca octoflora-Arkansas(Rosen; natural infection)
- Hordeum pusillum-Arkansas(natural infection)
- Hordeum jubatum-New York (Kirby; artificial inoculation)

Ophiobolus sp. (continued)
- Hystrix spp-New York (Kirby; artificial inoculation)
- Lolium spp.-New York (Kirby; artificial inoculation)
- Phalaris spp.-New York (Kirby; artificial inoculation)
- Setaria geniculata-Arkansas (Rosen, natural infection)

Phyllachora graminis
- Elymus canadensis-Minnesota
- Elymus robustus "

Puccinia ceanothi
- Tripsacum laxum-Arlington Farm, Virginia (J. A. Stevenson)

Puccinia coronata
- Festuca elatior-New York
- Lemnodia arkansana-Texas, Oklahoma (Christopher and Butler)
- Phalaris caroliniana-Texas, Oklahoma (Christopher and Butler)

Puccinia glumarum
- Elymus condensatus-Washington
- Hordeum jubatum-Idaho

Puccinia graminis
- Agropyron repens-near barberry, New York (Kirby), Minnesota.
- Agropyron tenerum-Minnesota
- Agrostis alba-near barberry, New York.
- Dactylis glomerata-New York (Kirby; near barberry)
- Hordeum jubatum-Minnesota, North Dakota, South Dakota.
- Elymus condensatus-Washington
- Festuca elatior-New York
- Lemnodia arkansana-Texas, Oklahoma
- Phalaris caroliniana " "

Puccinia polysora
- Tripsacum latifolium - Arlington Farm, Virginia (J.A. Stevenson)

Sclerospora graminicola
- Setaria viridis-New York (Hoerner) Iowa (Melhus - reduction 5%), Minnesota

Septoria agropyri E. & E.
- Agropyron repens - Wisconsin

Ustilago striaeformis
- Poa pratensis - Minnesota

SUNFLOWER

C. MISCELLANEOUS

Rust caused by *Puccinia helianthi* Schw.

Rust caused by *Puccinia helianthi* Schw. - reported from Illinois (general); Michigan (loss in silage value 10% - Coons); Wisconsin (less than usual, causing dropping of lower leaves - Vaughan); Minnesota (general and causing some damage); North Dakota (destructive to foliage on some varieties - Weniger); Colorado (present but unimportant - Learn); Arizona (reported from one locality but probably not common - Brown); California (Distribution general, importance slight).

The following reference summarizes work done in Minnesota on this rust: Bailey, D. L. Investigations on *Puccinia helianthi* Schw. (Abstract). Phytopath. 12: 44. Jan. 1922.

Wilt caused by *Sclerotinia* sp.

Montana: Serious in Gallatin County; reduction in yield for county 5%. Canker formed at the crown causing wilt and drying. Occurred also in Bitter Root Valley. Canada thistle found infected. (Morris).

Idaho: Reported from several parts of the state, but unimportant. (Hungerford).

Washington: Reported from three counties in the eastern part of the state. (Heald and Dana).

Quite destructive in wet seasons. (Frank).

The disease also was apparently common in Canada. (See Bisby, G. R. Stem-rot of sunflowers in Manitoba. Scient. Agr. 2: 58-61. Illus. Oct. 1921).

Bacterial wilt caused by *Bacillus solanacearum* EFS

Smith and Godfrey found that sunflowers were susceptible to *Bacillus solanacearum* when inoculated artificially. (Smith, Erwin F. and Godfrey, G. J. Bacterial wilt of castor bean (*Ricinus communis* L.) Jour. Agr. Res. 21: 255-261. May 16, 1921.)

THE PLANT DISEASE BULLETIN

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THE PLANT DISEASE SURVEY

Supplement 22

Diseases of Field and Vegetable Crops

in the United States in 1921

July 20, 1922

BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

DISEASES OF FIELD AND VEGETABLE CROPS IN THE UNITED STATES IN 1921*

Prepared by G. H. Coons+, Plant Pathologist,
Plant Disease Survey

CONTENTS

* Summaries of diseases of field and vegetable crops in the United States for the years 1918, 1919, and 1920 have been given in U. S. Dept. Agr. Plant Dis. Bul. Supplement 2: 42-83. 1919; 3: 84-118. 1919; 10: 180-273. 1920; 16: 177-287. 1921.

+ Temporary appointment while on leave of absence from the Michigan Agricultural Experiment Station.

INTRODUCTORY STATEMENT

The collaborators of the Plant Disease Survey, about 150 in number and located for the most part at the various state agricultural experiment stations, have supplied the information that has been used as a basis for this summary. In addition to the collaborators, other plant disease experts, in federal, state, and private work, have contributed many valuable notes. The pathologists of the Bureau of Plant Industry have been especially helpful in this respect. Reports of the market inspections made by the United States Division of Markets, Bureau of Agricultural Economics, have been used, and most of the American publications on the subject of diseases of vegetables that have appeared during the past year have been consulted and the references given.

Since the compiler has merely brought together the contributions from the various sources, it is preferred that writers when citing portions of this summary give credit to the original contributor rather than to the summarizer whenever possible.

Data on losses from vegetable diseases have been given freely throughout the following pages. Revised and complete estimates of losses for the diseases of potato, sweet potato, tomato, bean, and cotton are being worked out and will appear in the Plant Disease Bulletin Supplement 24 entitled "Crop losses from plant diseases in the United States in 1921". For final loss estimates on the above mentioned crops writers should consult that supplement.

Particular attention has been given in the following summary to the relation of weather to diseases and some correlations, between the influence of weather and distribution and severity, have been made. Readers are referred to the rather complete account in the Plant Disease Bulletin Supplement 20, "Diseases of fruit and nut crops in the United States in 1921", for a summary of general weather conditions in 1921.

As is shown in the table of contents, the information has been summarized by crops and by crop groups, some of our more important crops being given first and the less important ones arranged alphabetically at the end. Since the control of potato diseases is accomplished largely by the practice of a few important measures, it has seemed best to summarize the results obtained in this field during the past year under separate headings, namely; seed certification, seed treatment, spraying, and dusting. A discussion of the individual diseases of potatoes and the other crops is then taken up in the remainder of the summary.

POTATO

Seed certification

The outstanding feature of potato work in the United States and Canada during the last few years is the remarkable extension of the potato certification movement. This work, in close touch with extension and investigational agencies in the States and Canada, is partially meeting the situation brought about by the progressive deterioration of potato varieties by disease.

It may be said that varietal standardization has already been accomplished so far as standard types are concerned, but the potato certification work has not as yet advanced to the point where it deals with pure lines of high productive power.

It is necessary that standards be raised and that inspections in the various states be uniform and consistent. Undoubtedly, the time is ripe for a field conference of workers and men in charge of inspection work, but such conference, to be most successful, must needs come during the height of the inspection season. It is to be hoped that the summer conference of the Phytopathological Society in August 1922 may serve to bring about greater standardization of practice and conformance to the best standards of excellence.

The following extract from a letter by the United States Department of Agriculture, Office of Cotton, Truck, and Forage Crop Disease Investigation, to workers interested in potato seed improvement, throws light on some of the seed potato problems that must be met by inspection and certification.

> "It has not been so easy to control leaf-roll and mosaic as might be wished. Recent reports indicate that a good deal of certified stock sent out from fields in the North to southern points has developed a large percentage of leaf-roll or mosaic. For example, at the Experiment Substation at Onley, Virginia, this season, one plot of Irish Cobblers grown from northern certified seed showed 42% leaf-roll as well as some mosaic and other degeneration troubles, such as dwarfing, upward growth, etc.; another plot of the same variety from northern certified seed showed 7% leaf-roll. At Alexandria, Louisiana, in April 1921, fields planted with northern certified Triumph seed stock showed between 70 and 80% of mosaic infested plants. In June 1920, a 200-acre potato field near Charleston, South Carolina, planted with northern certified Irish Cobblers showed leaf-roll or mosaic (accompanied by curly dwarf and spindle sprout) affecting 90% of the hills."

Nearly all states report an increase in the number of acres inspected and with the more favorable yield of 1921 this has meant a heavy increase in bushels of certified potatoes available for use. The significance of this body of high grade seed stock in reducing losses is apparent.

Another noteworthy thing is the report on premium paid for certified stock. In other years when the premium was approximately 25¢ a bushel, the growing of certified seed stock was a good practical proposition, not alone for the slight margin over market price, but because of the greater sureness of a market. The prices reached with the 1920 crop and again with the 1921 crop are such as to insure repayment for the time, trouble, and extra expense of producing certified seed, and this premium seems necessary if the matter of production of certified seed is to be permanent. The producer of good seed potatoes deserves a legitimate profit.

Table 31. Summary of potato seed certification in the United States and Canada in 1920 and 1921. (Summarized by A. G. Tolaas.)

Place	Agency handling inspection	Year	Applications	Acreage	Certified: No. of fields	Certified: Acreage	Certified: Bushels	Difference in: price per cwt. above ordinary stock	Varieties certified	No. of inspections
Me.	E.L.Newdick, State Dept. of Agr., Augusta	1920	76	577	42	462	130,000	60¢	Green Mountain, Irish Cobbler, Spaulding Rose	3
		1921	118	1,315		608	217,360	60-70¢	Same as 1920 and Mills Pride	
N. J.	H. B. Weiss & M.T.Cook, Plant Pathologist, State Dept.Agr.	1920	31	197		158			Irish Cobbler, American Giant, Mills Pride, N. J. Red Skin	1
	E. West, State Dept.Agr.& N.J. Potato Growers Assoc., Trenton	1921	85	907.75		573.5			Same as 1920	
N. Y. (a)	E.V.Hardenburg, Potato Growers Assn. and Dept. Plant Path.Col. Agr., Ithaca	1920	195	1,270	196	766	189,242	75¢	Green Mountain, Smooth and Russet Rural New Yorkers, American Giant, Irish Cobbler	3
	M.F.Barrus, Dept. Plant Path. & J.M.Hurley, N.Y. Cooperative Seed Potato Assn., Syracuse	1921	177	1,210	200	773	172,146	$1.20-1.65	Green Mt., Norcross No. 9, Sir Walter Raleigh, Dibbles Russet, Russet Rural, Amer. Giant, Irish Cobbler, Mill Prize, Heavyweight	
(b)	Same service to: 9 Farm Bureaus	1920	87	300		209	45,203			
		1921	76	348		283	47,769			

Place	Agency handling inspection	Year	Applications	Acreage	Certified: No. of fields	Certified: Acreage	Certified: Bushels	Difference in price per cwt. above ordinary stock	Varieties certified	No. of inspections
Pa.	R. E. Hartman, State Dept. Agr. Harrisburg	1920			12		25,000	50¢	Rural New Yorker Russet Rural New Yorker	3
	Same as above	1921		400	23	68	24,875	80¢-$1.20	Russet Rural Spaulding Rose	
Vt.	A. H. Gilbert, State Dept. Agr.	1920	206	550	90	282	3,450	Avg. $1.00	Green Mountain Irish Cobbler	2
	Burlington	1921	203	782	130	480	100,000	75¢-$1.50	Same as 1920	
Mich.	H.C.Moore, Mich. Potato Producers	1920	60	269	42	192	26,000	80¢-$2.00	Russet Rural Green Mountain	3
	Assn. and Mich. Agr. College, East Lansing	1921	146	1,030	98	660	97,000	80¢-$2.00	Same as 1920 and White Rural Irish Cobbler	
Minn.	A.G.Tolaas, Minn. Board for Seed Potato Inspection & Certification, Uni.	1920	610	4,241	345	2,421	317,975	25¢-$1.00	Early Ohio, Green Mt., Irish Cobbler, Burbank Russet, King Rural New Yorker Bliss Triumph	3
	Farm, St. Paul	1921	504	4,582.5	381	3,783	605,280	35-75¢	Same as 1920	
Wis.	J. G. Milward, Hort. Dept., Col. of Agr., Madison	1920	255	1,735	137	1,075	194,000	50-75¢	Rural New Yorker Green Mountain, Bliss Triumph, Early Ohio, Irish Cobbler	2*
		1921	---	---	---	---	--- ---	--		
Nebr.	H. O. Werner, Agr. Ext. Service	1920	35	660	17	251	21,770	75¢-$2.00	Bliss Triumph Early Ohio	2
	Lincoln	1921	62	1,085	29	656	44,885	$1.00-1.60	Same as 1920	

Place	Agency handling inspection	Year	Applications	Acreage	Certified: No. of fields	Certified: Acreage	Certified: Bushels	Difference in price per cwt. above ordinary stock	Varieties certified	No. of inspections
Colo.	E. P. Sandsten, State Horticulturist, Ft. Collins	1920	200	1,000	40			$1.00-1.50	IrishCob., Bliss Tri. Pearl, Brown Beauty, Russet Rural N. Y.	2
		1921	---	---	---			----		
Ida.	E.R.Bennett, Agr. Ext.Div.Uni.Ida. Boise	1920	145	620	20	129	3,500	50-150%	Netted Gem, Idaho Rural	3
		1921	---	---	---	---	- ---	----		
Calif.	W.V.Shear, State Dept. of Agr. Sacramento	1920	18	514	25	424	26,000	$1.00-2.00	British Queen, White Rose, Burbank, Amer. Wonder, Red Prizetaker	3
	Same as 1920	1921	27	803	25	438	90,000	50% increase	Same and Gt.Divide	
Ore.	W. S. Carpenter, Agr.Col.Corvallis	1920	130	494	12	43	4,710	75¢-$1.00	Netted Gem, Burbank, Early Rose	3
	G.R.Hyslop, Agr. Col., Corvallis	1921	288	1,355		387		75¢	Netted Gem, Earliest of All, Early Rose	
Wash.	J. E. Currey, State Dept.Agr. Olympia	1920	37	238	28	206	14,700	50-100%	Netted Gem, Burbank, American Wonder	4
		1921	105	572	85	447	23,530	50%	Netted Gem, Burbank, Idaho Rural, Early Ohio, Amer. Wonder	
Canada	Geo. Partridge, Div. Bot., Dept. of Agr., Ottawa	1920	1,274	7,613		3,956	234,552	40¢	Green Mt., Garnett Chili, Irish Cobbler, Early Ohio, Rural New Yorker	**
	Same as 1920	1921	1,349	7,900	1,634	4,328	293,838 incomplete	40-60¢	Same as first 4 above with Dooley, American Wonder, Empire State	

*Field and bin inspections. **Field, bin, and shipping inspections.

It will be noted that in Table 31 forty-two varieties of potatoes are listed. It is worthy of note that so many varieties are being certified. Many of these are synonyms and some are "trade names". It will be a step in advance when this list of names is strongly cut and some system of variety naming is adopted to permit better understanding.

The potato certification agencies have never done enough follow-up work with their products to secure the telling figures showing the superiority of certified over common seed. The following statements and figures from various states deserve record:

New York: The yields of the inspected fields were twice as high as the average for the state. (Barrus).

Michigan: Special efforts to test Michigan-grown seed in other states were made in 1921. Seven-hundred-thirty seven hundred-pound sacks were used in the tests in five states and the following records were secured:

Table 32. Results of tests of Michigan certified seed made in various states in 1921. (H. C. Moore).

State	No. of 100# sacks furnished	No. of records secured	Average increased yield per acre over home-grown seed produced by Michigan certified seed.
Pa.	390	75	62.5 bushels
Ohio	15	6	2.6* "
Ind.	85	21	63.0 "
Ill.	220	61	44.0 "
Iowa	27	6	61.2 "

*Compared with New York Certified Rurals.

Minnesota: The demonstrations were tried in 1921 in approximately 50 of the counties of Iowa. Owing to the extreme weather conditions which prevailed, the results are more or less inconclusive. The year before Professor Fitch of the Iowa Station carried on similar demonstrations on a smaller scale and reported very good results in favor of the certified product. (A. G. Tolaas).

Colorado: Tests made by the writer at Eagle during the past season indicate that certified seed yields more potatoes to the acre and the quality and vigor are better. (C. M. Tompkins).

Recent literature

Gilbert, Alfred H. Certified seed inspection in Vermont. Potato Mag. 3^7: 6, 20-21, 26. 1921.

Hardenburg, E. V. Seed potato problems. Potato Mag. 3^{10}: 22-23, 25, 30. 1921.

Tolaas, A. G. Seed certification makes great progress. Potato Mag. 3^{12}: 9-11, 25. 1921.

Seed treatment

The hot formaldehyde method of Melhus has continued in favor in several states. Blodgett and Perry[1] tell of 9,000 bushels being treated by this method. From this test it was found that the addition of .9 of a pint of formaldehyde per 50 bushels treated would maintain the desired concentration of formaldehyde (3.6 gms. per liter).

The following statement and tables concerning results of seed treatment in New York have been furnished by the collaborators of that state. (See potato scab for comments from other states.)

Table 33. Results of potato seed treated with hot formaldehyde in New York State during 1921. (Barrus and Chupp).

County	Number of tests	Length of treatment	Yield in bushels		Gain or loss
			Treated	Untreated	
Allegany	2	2 minutes	217.8	197.4	+20.4
Genesee	1*	-	257.3	260.2	- 2.9

* Ten replications.

Table 34. Results of potato seed treated with mercuric chloride in New York State during 1921. (Barrus and Chupp).

County	Number of tests	Length of treatment	Yield in bushels		Gain or loss
			Treated	Untreated	
Allegany	1	1.5 hours	268.0	246.6	+21.4
Chemung	5	1.5 "	189.2	154.2	+35.0
Cortland	1	1.5 "	160.0	140.0	+20.0
Erie	1	1.25 "	170.0	170.0	0.0
"	1	1.25 "	307.0	279.0	+28.0
"	1	1.5 "	236.0	268.0	-32.0
"	18	1.5 "	158.8	127.9	+30.9
Genesee	1*	.5 "	219.8	260.2	-40.4
"	1*	1.5 "	225.6	260.2	-34.6
Livingston	2	-	190.0	126.0	+64.0
"	1	-	224.0	259.0	-35.0
Onondaga	3	1.5 hours	164.5	150.6	+13.9
Orleans	3	1.5 "	140.6	126.1	+14.5
Total....	39	Averages.......	177.2	154.8	+22.4

* Ten replications.

"One cannot draw conclusions in regard to the value of potato seed treatment from the results of a few tests in one county. But if a large number of tests are included, not only from different counties but also during a series of years, and each report consistently points to appreciable gains in yield, the accumulation of benefits should bear considerable weight. In the table are listed the gains for four consecutive seasons. It will be observed that during 1918 and 1921 the increased yields were not so pronounced. The weather during these seasons was hot and dry, so that conditions generally

were unfavorable for potato production. Even then the gains were sufficient to more than pay for the cost of treating. Each field which showed a decreased yield is listed separately, so that it stands out prominently, showing that occasionally, due to one or more of numerous possible reasons, the yields are decreased. Where data are available in such cases, however, the increased smoothness of tubers and uniformity in size usually are sufficient to offset any decrease in yield." (Barrus and Chupp).

Table 35. Summary of results of all potato seed treatments in New York State. (Barrus and Chupp).

Year	Number of Counties	Number of Tests	Average yield in bushels: Treated	Average yield in bushels: Untreated	Average gain or loss
1921	8	42	181.0	159.4	+21.6
1920	8	38	277.0	244.9	+33.0
1919	7	28	237.0	189.0	+48.0
1918	4	49	201.0	187.0	+14.0

Total number of tests 157 Average gain............... +30.1

Recent literature

Cited

1. Blodgett, F. M. and F. R. Perry. Additions of formalin to maintain the concentration uniform with direct steam heat in the hot formaldehyde treatment of potatoes. Phytopath. (Abstract) 12: 39. Jan. 1922.

Not cited

Porter, R. H. A two-minute treatment of seed potatoes. Potato Mag. 3⁹: 8-9. 2 fig. 1921.

Spraying

The following statements and figures with reference to spraying for leaf diseases have come to the Office of the Plant Disease Survey during the past year:

New York:

Table 36. Results of potato spraying in New York previous to 1921. (Barrus and Chupp).

Year	Number of Counties	Number of Tests	Was blight present	Average yield per acre of Sprayed	Average yield per acre of Check	Average gain or loss
1920	11	57	Yes	277.0	206.0	+71.0
1919	4	14	Yes	339.0	274.5	+54.5
1918	7	28	No	173.6	141.1	+32.5
Average gain for three year period, 1918-1920........						+49.3

Table 37. Results of potato spraying in New York during 1921. (Barrus and Chupp).

County	No. of tests	Fungicide used	No. of applications	Was blight present	Total cost	Yield per acre Sprayed	Yield per acre Check	Gain or loss
Erie	1	6-8-60	5	No	$ 4.58*	199.0	172.0	+27.0
Washington	2	4-4-50=1 6-6-50=7	8	No	18.00	280.0	239.5	+40.5
	1	4-4-50=1 6-6-50=7	8	No	18.00	153.0	163.0	-10.0
Orleans	3	6-6-50 5-5-50 5-8-50	2 5 4	No	6.54	130.4	111.9	+18.5
Steuben	1	Replicated 144 times	8	No	- --	244.0	198.0	+46.0
Onondaga	14	4-4-50=3 5-5-50=2	4 or 5	No	10.50	200.8	153.3	+47.5
Total tests	22							
Averages			5	No	10.72	198.1	158.8	+39.3

*Plus labor

Spraying did not give as big an increase in yield during the hot dry seasons of 1918 and 1921 as it did in the cooler and more humid seasons of 1919 and 1920. In the latter seasons the potatoes naturally yielded higher, and also because much blight was present, the difference between sprayed and unsprayed was very marked.

West Virginia:

Table 38. Results of spraying tests in West Virginia as reported by Giddings.

Variety	Place	No. of applications	Dates	Results	Remarks
Irish Cobbler	Wheeling	4	5-27, 6-6 6-20, 6-30	25% gain	Practically free from all diseases except tip-burn
Common	Parkersburg	3	6-12, 6-16 6-27	20% gain	Tip-burn severe
An early variety	Parkersburg	4	5-21, 6-2 6-16, 6-27	No gain	Tip-burn severe
An early variety	Fairmont	5	5-14, 5-26 6-4, 6-17, 7-1	33 1/3% gain	

Variety	Place	No. of applications	Dates	Results	Remarks
Not stated	Davis	3	Not given	37.5% gain	Very little late blight
Not stated	Davis	3	Not given	29.4% gain	Very little late blight

Ohio: Forty-seven Ohio potato growers in 9 counties during 1921 made 60 tests on one-half acres or more of potatoes. Thirty-four of these growers left check rows unsprayed, and 31 of these received a profit. From 4 of the 60 tests, insufficient increases were received to offset the cost of spraying. The average increase for all tests was 31 bushels per acre. Hopperburn (tipburn) of the leaves was the main potato trouble against which control was secured. This disease is caused by leafhoppers which enter the fields in midsummer. Bordeaux mixture, 5-5-50, was used. Besides being a fungicide, this is known to repel the leafhoppers. During the growing season, 3-4-5-and 6 applications were made at two weeks' intervals. Four applications of spray gave the highest net gain ($55.70 per acre). From 75 to 90 gallons per acre per spray were found to be advisable. Power, traction, and hand-pump outfits were all used in these tests. Power sprayers gave better results than traction outfits. All sprayers, with one exception, were equipped with three nozzles per row. Two nozzles were directed up and one down, an effort being made to cover both sides of the leaves. Results indicate that 3 nozzles per row are absolutely essential for effective spraying. Rods equipped with 3 nozzles per row and operated by hand gave the most thorough covering of foliage. Extra labor required increases the cost of this method of spraying. (Parks and Clayton[1]).

Table 39. How spraying potatoes with Bordeaux mixture paid in Ohio in 1921. (Parks and Clayton).

No. of sprays	All types machines			Traction sprayers			Power sprayers		
	No. of tests	Increase in bu. per acre	Net gain per A.	No. of tests	Increase in bu. per acre	Net gain per A.	No. of tests	Increase in bu. per acre	Net gain per A.
3	24	20.9	$23.85	14	16.0	$16.50	9	28.9	$35.85
4	10	43.8	55.70	3	33.5	40.25	5	47.6	61.40
5	14	40.4	48.30	-	-- -	-- --	12	43.2	52.35
6	8	33.2	34.87	8	33.2	34.87	-	-- -	-- --

England: The following results of English tests are of interest[2]: "Spraying has increased total yield of all plots in the nine years' average."

Table 40. Nine years' average of results of spraying tests, for the control of late blight, conducted in England.

	Not sprayed	Sprayed once, early	Sprayed once, late	Sprayed twice, early and late
	Cwt.	Cwt.	Cwt.	Cwt.
Ware#	90.40	105.69	108.65	115.23
Seed	28.82	32.09	30.82	31.41
Chats*	18.49	17.48	17.89	16.79
Diseased	8.00	8.92	6.61	6.97
Total	145.75	164.00	164.00	170.50

Ware - marketable. *Chats - small potatoes.

Literature cited

1. Parks, T. H. and E. E. Clayton. Does spraying potatoes with Bordeaux pay? Ohio State Univ. Ext. Leaflet. 1921.
2. Pennington, S. and H. G. Robinson. Spraying of potatoes for blight or potato disease, (Phytophthora infestans). Bul. Univ. Col. Reading 30: 9. June 1921.

Dusting

A number of collaborators have furnished reports, which are given below, regarding the use of dusts for the control of leaf diseases of the potato:

New York: Last year, Professor Whetzel in his conclusions on the results of potato dusting work said that more carefully planned and more extensive tests must be made before the question of the relative values of dusting and spraying is finally decided. Such tests were conducted this year but the question is not yet answered. It may require several years of experimental work before it can be answered.in a satisfactory manner.

Weather conditions were not favorable for the development of late blight in most parts of the state. As a result of late blight was not a factor in these experiments with the exception of those on Long Island where this disease was of considerable importance. In all the previous recorded experiments with Bordeaux mixture, the most significant increases in yields due to spraying have been obtained when late blight has been a factor of importance, while during non-blight years the increases from spraying have been only normal and on the average sufficient only to pay for the cost of application. Copper-lime dust is a substitute for Bordeaux mixture spray and the most significant results from its use would seem to come when blight is an important factor.

It will be noticed from the average yields of each experiment that there is a consistent increase in yield of the dusted rows over the checks. In only one case was there a decrease, this being where potatoes, planted in muck, died early in the season before the advantages of the application could overcome the injury caused by the use of the dusting machine. In a majority of the experiments where a power duster was used the increases

are significant and indicate, even in the absence of blight, a beneficial effect from the dust. The increases, however, are somewhat smaller than those obtained from the Bordeaux spray, except in one experiment.

From the experiments we must conclude that copper lime dusts under the conditions applied this year afforded protection to the vines as indicated by the increase in yield over vines not dusted, that they afforded ample protection against late blight, but that the protection through the application of these materials by power and traction machines against such injuries as tip-burn, hopper-burn, and those caused by flea beetles was not as great as that afforded by Bordeaux mixture applied with a good traction sprayer. It is apparent that the power duster was more efficient than the traction duster and that dusting with a hand machine gave the best results in yield due, probably, to better distribution of material and to absence of machine injury to the plants. (M. F. Barrus. Potato dusting experiments in New York during 1921. (For complete account of tests write Department of Plant Pathology, Cornell University).

Pennsylvania:

Table 41. Results obtained in Pennsylvania on dusting potatoes, 1921.

Application	Yield per acre, bushels			
	Adams County No. 1	Adams County No. 2	Lehigh County	Schuylkill County
Bordeaux 4-4-50	208.5	198.2	208.5	Increase of sprayed
Copper dust	210.0	187.2	172.5	over dust, 40 bu.
Check	177.0	139.6	168.7	Yields not given

The data for Adams County were supplied by R. C. Walton.
Those for Lehigh and Schuylkill Counties were supplied by E.L.Nixon.

Ohio: Fourteen tests with Bordeaux dust and other potato dusting mixtures gave results greatly inferior to those secured by spraying. (Parks and Clayton).

Michigan: Some control of leaf hopper by both Bordeaux spray and copper lime dust. Early blight, late attack, not controlled. In general, results favorable with dust, given proper timing of applications. (J. E. Kotila).

Wisconsin: Dusting experiments were conducted with potatoes at this station using both powdered Bordeaux and uncombined Bordeaux or monohydrated copper sulphate and lime. When foliage was thoroughly dusted on the under side it appeared these two dusts repelled the potato leaf hopper and controlled hopper burn fully as well as when liquid Bordeaux was used. The season of 1921 was very dry, however, permitting the dusts to remain thick on the foliage much longer than the ordinary season. With an arbitrary standard of three or four applications of dust and spray, I doubt whether Bordeaux dust would give the protection against hopper burn which is possible with liquid Bordeaux. I do not consider last season's results conclusive. (John E. Dudley, Jr.).

Minnesota: Inconclusive. (Leach).

Iowa: We tried out on a very small scale, dusting of potatoes for the leaf hopper with powdered Bordeaux mixture, but it was entirely ineffective. (F. A. Fenton).

Diseases

Late blight caused by Phytophthora infestans (Mont.) De Bary

The year 1921 may be considered as a year in which a late blight epidemic was averted by the general high temperatures and drouth prevailing in the early half of the growing season. Nineteen-twenty was considered the worst blight year for the late potato states since 1915. Accordingly, late blight was expected to be rather serious when first reported, but climatic conditions operated to check the spread from primary sources.

Distribution and importance of late blight in 1921

Late blight in 1921 was reported from Maine, New Hampshire, Vermont, Massachusetts, New York, Pennsylvania, Maryland, West Virginia, North Carolina, Michigan, Wisconsin, South Dakota, and Washington; and, according to Colin G.

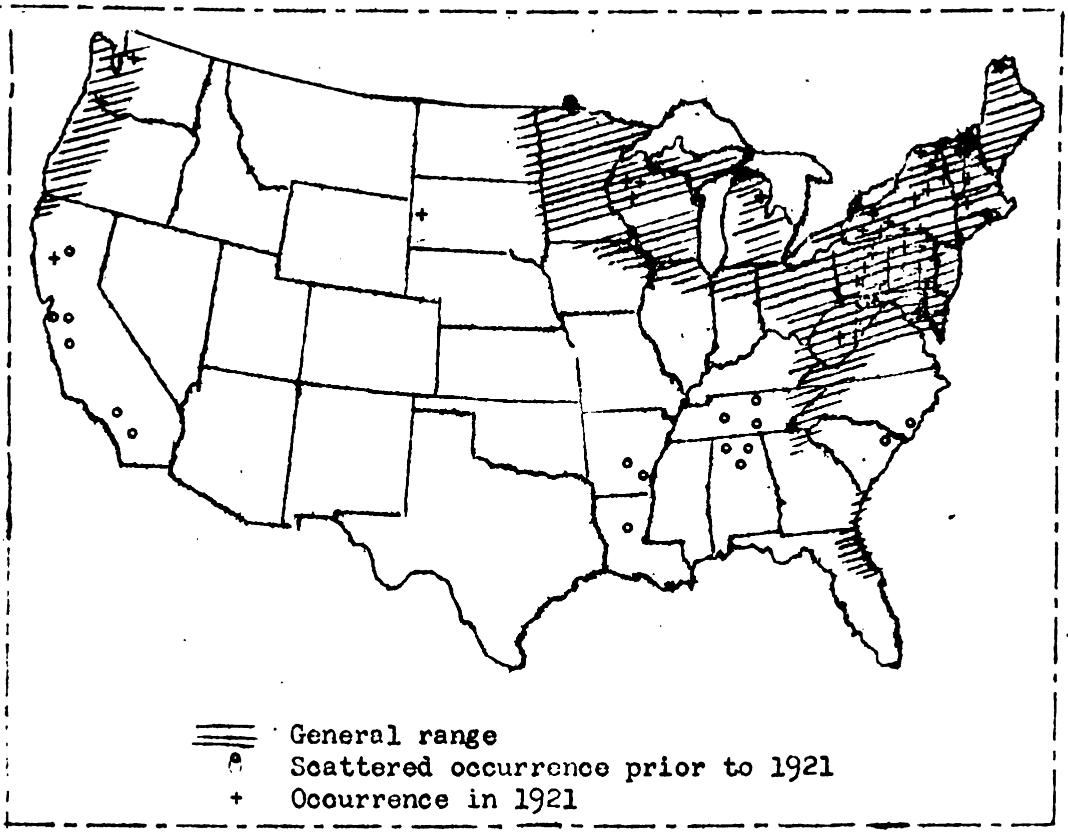


Fig. 64. Approximate known range of Phytophthora infestans, and occurrence record for 1921.

Welles[1], it occurred in the Philippine Islands at Trinidad, Mountain Province. In all states except Pennsylvania and a portion of West Virginia blight was of minor importance in its effect on the foliage. With the scattering infection considerable loss from tuber rot in some shipments has been reported by market reporters from Maine and New York.

The range in 1921 again shows the strong influence of July rainfall (Figs. 64 and 65), the areas in nearly every case coinciding closely with the rainfall map for July. (cf. Coons, G. H. Michigan potato diseases. Michigan Agr. Exp. Sta. Spec. Bul. 85: 5-49. Illus. 1918). (Rainfall maps for August and September are given under discussion of early blight distribution).

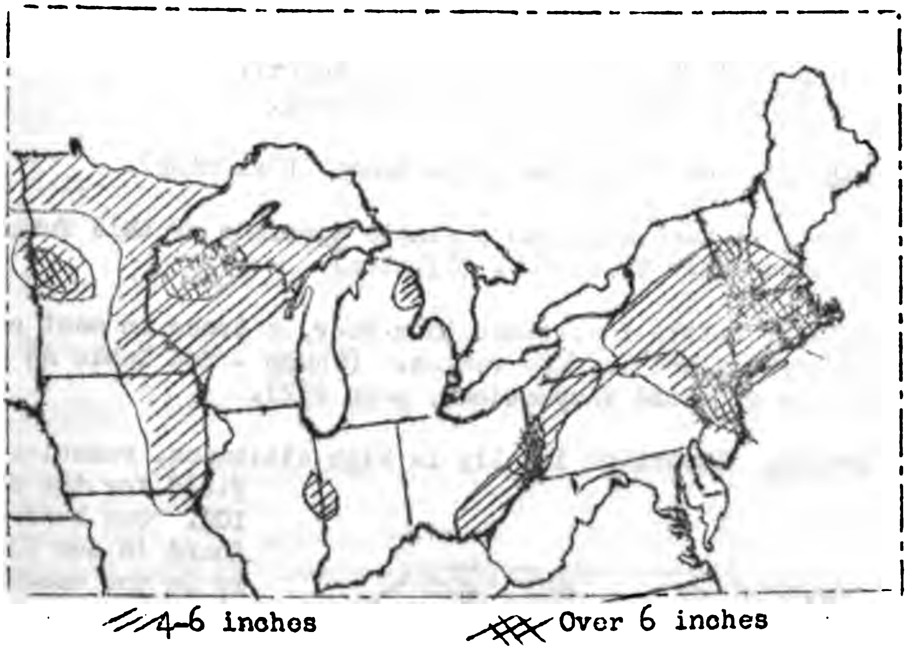


Fig. 65. Total precipitation for July 1921. (Adapted from Nat. Weather and Crop Bul., series 1921[33]: 7. Aug. 17,1921.)

Some of the more significant reports of the collaborators and others concerning late blight are given below:

Maine: (Aroostock County): There is not any late blight of economic importance. Undoubtedly, Aroostock County has been much more favored with rain than any other part of the state, and the record is as follows: May 1.63 inches, June 1.58 inches, July 2.49 inches, and August 5.43 inches. If the previous three months had been wet, the August rainfall would mean something, but lack of rain in May, June, and July, in my opinion, put late blight out of business so far as doing any damage in Maine is concerned... (W. J. Morse, September 10).

Late blight is really here (Aroostock), but so slight that it would be overlooked by almost any one but a trained observer. It will not be a factor in yield, but may result in an occasional rotted tuber, particularly if the digging has to be done under wet conditions...... However, a frost that may come at any time now, would largely, if not entirely eliminate danger from rot. (Morse, September 13).

New Hampshire: Late blight has been very scarce and we will have very little tuber rot. We have had a very dry summer and have seen the disease only once in an unsprayed field (September 14), and while it was well distributed, the damage done was negligible. (Butler).

Vermont: In the Connecticut River Valley, near Brattleboro, there has been a general infection of several fields. In Orange County, light infections in only one or two fields. These latter seemed to originate at the time of rains, but dry weather coming on the blight was checked...... In the Brattleboro case, I believe that the infection has been brought on by the heavy mists which have been prevalent there recently. (Gilbert).

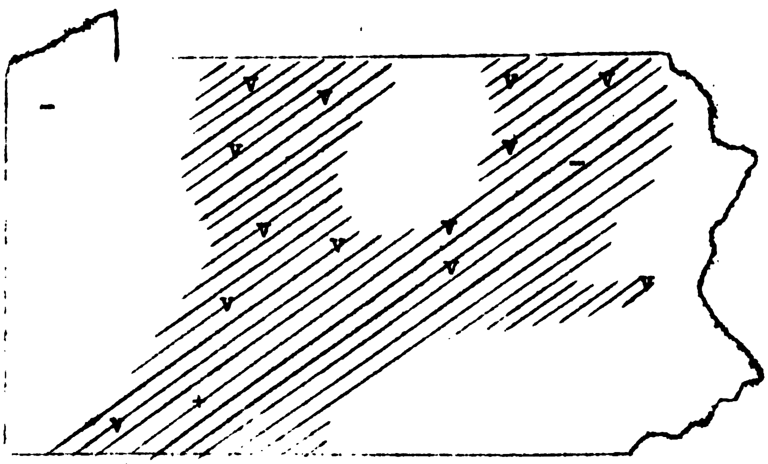
Very little, perhaps 1%. (Lutman).

Rhode Island: Not of serious importance. (Browning).

Connecticut: I have not seen a single specimen of this fungus on potatoes here this year. (Clinton).

New York: Of little importance this year, a trace in most counties. Too dry and hot for the fungus. (Chupp - See Table 43 showing results of field inspections, page 272).

Pennsylvania: Important locally in high altitudes, reducing the yield for the state 5 to 10%. One hundred percent found in one field. Mostly in the mountainous section, none in the southeastern part. The following reports by counties may be made: Fayette, 30%; Somerset, 25%; Susquehanna, 30%. (Thurston and Orton).



═══ Areas of highest elevation
+ Severe loss
v Moderate loss
\- Slight loss

Fig. 66. Late blight distribution in Pennsylvania, 1921, showing relation to mountainous areas.

Maryland: Less prevalent than usual. (Temple and Jehle).

West Virginia: Local in high altitudes in Randolph and Tucker Counties. Mr. Sherwood found late blight at Beverly in Randolph County. The same seed was used for three other patches and blight was very prevalent in all fields planted with that seed. He considers this condition due to the planting of infected seed as adjoining fields did not show evidence of blight at that time, July 7-8. (Giddings).

Kentucky: A very slight amount of late blight reported in October from Louisville. (Valleau).

North Carolina: Very common this year in some mountainous sections. Potatoes were planted rather early, the weather was abnormally warm, and blight did not appear before the potatoes were dying. Did slight damage to the winter crop grown on the Eastern Shore. (Foster).

Michigan: Specimens in early phase of decay from Alpena County, September 4. Specimens were seen and reports of tuber rots in car shipments confirm existence of blight in this section. (Coons).

Wisconsin: Of minor importance in local areas (Price, Rusk, and Washburn Counties), reducing the yield for the state very slightly. The maximum found in any one field was 75%. First reported September 27. It is probably attributable to local showers. (Vaughan).

Minnesota: Not observed this season. (Section of Plant Pathology).

Iowa: None present. (Melhus).

South Dakota: About 5% found in one field near St. Onge. (Petry).

California: Late blight was severe in Humboldt County. There are 400 acres of potatoes, of which about 150 acres are affected. It seems that this disease as found in Humboldt County does not develop readily elsewhere. (Milbrath).

Philippine Islands - Trinidad, Mountain Province: The temperature of this region, due to the high altitude, is rather low compared with the rest of the Philippines. The most serious disease prevalent during the period in which observations were made, was the late blight of potatoes. According to Mr. Wright, Superintendent of the Trinidad Farm School, this disease is the limiting factor in Irish potato production. Likewise the disease is very serious on tomatoes and is also the limiting factor in their production. Late blight is easily checked by spraying with Bordeaux mixture every two weeks throughout the growing season; so the loss which has hitherto resulted from this disease may be entirely prevented. (Colin G. Welles[1] - December).

Losses from late blight in 1921

Table 42. Estimated reduction in yield from late blight as reported by collaborators, 1921.

Percent reduction in yield	States
5	Pennysylvania
2	West Virginia, North Carolina
.5-1	Maine
.3	New York
t	Michigan, Wisconsin, Washington, Oregon

Table 43. Losses from late blight in New York State by Counties for 1921. (Chupp).

County	Percent of crop loss	County	Percent of crop loss	County	Percent of crop loss
Allegany	0.24	Essex	v.s.	Steuben	v.s.
Broome	v.s.	Franklin	v.s.	Suffolk	v.s.
Cayuga	0.16	Genesee	v.s.	Tioga	v.s.
Chemung	v.s.	Livingston	v.s.	Tompkins	v.s.
Chenango	v.s.	Nassau	v.s.	Warren	v.s.
Clinton	v.s.	Oneida	0.24	Washington	v.s.
Cortland	0.85	Onondaga	v.s.	Wyoming	v.s.
Erie	v.s.				

v. s. Very slight. (A trace was reported from most counties.)

Table 44. Losses from late blight of potatoes, caused by Phytophthora infestans, as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	Range of dates of inspection	No. of cars with decay	Average percentage of decay	Range of percentages of decay: No. cars	Range of percentages of decay: Percent	Remarks
		1920 crop				
Delaware	April 25	1	4	1	4	With slimy soft rot
Florida	April 13-29	4	36	2	60-70	
				2	1-12	
Idaho	Febr. 7	1	5	1	5	With Fusarium
Maine	Jan. 10-June 17	135	3	20	5-14	
				115	1-4	
Maryland	April 20-June 4	4	4	4	2-9	
Michigan	Jan. 13 - May 31	11	3	1	10	
				10	2-4	
New Jersey	March 16	1	5	1	5	With Fusarium
New York	Jan. 6 - June 10	139	3	33	5-10	
				106	1-4	
Oregon	Jan. 14	3	24	3	18-33	
Pennsylvania	Jan. 5 - May 2	17	5	10	5-14	
				7	1-4	
Virginia	March 15-June 22	6	2	6	1-5	
Wisconsin	Jan. 5	1	3	1	3	
Canada	Jan. 8 - June 2	38	2	5	6-9	
				33	1-4	
Unknown	Jan. 28-June 10	9	6	1	35	With slimy soft rot
				8	1-4	
Total		370				

Origin of shipment	Range of dates of inspection	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Remarks
		1921 crop				
Maine	Sept. 20-Dec. 12	100	4	1	40	With other decays
				16	5-20	
				83	2-4	
Michigan	Oct. 28 - Dec. 1	9	5	3	5-12	
				6	2-4	
New Jersey	Sept. 1	1	2	1	2	
New York	Sept. 13-Dec.12	48	3	6	5-15	With other decays
				42	1-4	
North Carolina	June 6-17	2	31	2	5-57	" " "
Pennsylvania	Nov. 10-23	2	2	2	2	
Virginia	Nov. 30	1	1	1	1	
Washington	Oct. 26	1	5	1	5	
Unknown	Nov. 1-18	4	4	1	9	
				3	1-4	

Total..................... 168
Total number cars potatoes inspected (calendar year)... 2749

Dates of first observation of late blight, 1921

April 14........... Florida
June 23............. Suffolk County, N. Y. (Chupp)
July 2.............. Randolph County, W. Va. (Giddings)
July 7-12........... Avery County, North Carolina (Shapovalov)
July 26............. St. Onge, S. D. (Petry)
July 30............. Humboldt County, Calif. (Milbrath)
August 5............ Somerset Co., Pa. (Well distributed, Nixon)
August 15........... Bath, Steuben County, N. Y. (Fernow)
August 20........... Present in 9 counties in Pa. (Thurston)
September 1-13..... General outbreak in New York (Chupp)
September 4......... Alpena, Mich. (Coons)
September 8......... Brattleboro and in Orange Co., Vt. (Gilbert)
September 11 .... Amherst, Mass. (Osmun)
September 13........ Aroostock County, Me. (Morse)
September 14........ New Hampshire (Butler)
September 27........ Park Falls, Price County, Wis. (Vaughan)
Digging time........ Price and Rusk Counties, Wis.

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List of books quoted: p. 123-125.

Early blight caused by Macrosporium solani E. & M.

This disease, referred to in the 1920 summary (Pl. Dis. Bul. Suppl. 16: 187-188. June 1, 1921.) as one of the four or five most universal potato diseases in the United States and which was in 1920 of slight importance, was this year, in contrast to 1920 conditions, of great importance in many states as the following table of losses indicates:

Table 45. Losses from early blight in 1921, as reported by collaborators.

State	Percent loss	1921 December forecast	Loss computed in bushels
West Virginia	3.0	4,080,000	126,000
Kentucky	15.0	3,770,000	665,000
Tennessee	5.0	1,820,000	96,000
North Carolina	1.0	4,048,000	41,000
Mississippi	2.0	1,088,000	22,000
Texas	1.0	2,072,000	21,000
Ohio	1.0	6,728,000	68,000
Indiana	1.5	3,570,000	54,000
Michigan	10.0	27,200,000	3,022,000
Minnesota	1.5	27,525,000	42,000
South Dakota	2.0	4,400,000	90,000
Kansas	5.0	4,160,000	219,000
Colorado	10.0	11,070,000	1,230,000
Utah	1.0	2,415,000	24,000
California	2.0	10,064,000	205,000
Total			5,925,000

The following states reported early blight as of less importance than last year, with losses under 1%: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Florida, Mississippi, Louisiana, Arkansas, Wisconsin, Iowa, North Dakota, Arizona, and Idaho.

The following reports from western states, reiterative of similar reports for 1920 are worthy of record and conditions in the areas merit further investigation.

Montana: Reported no early blight seen, doubt if it occurred this year - found only once in past ten years. (Jennison).

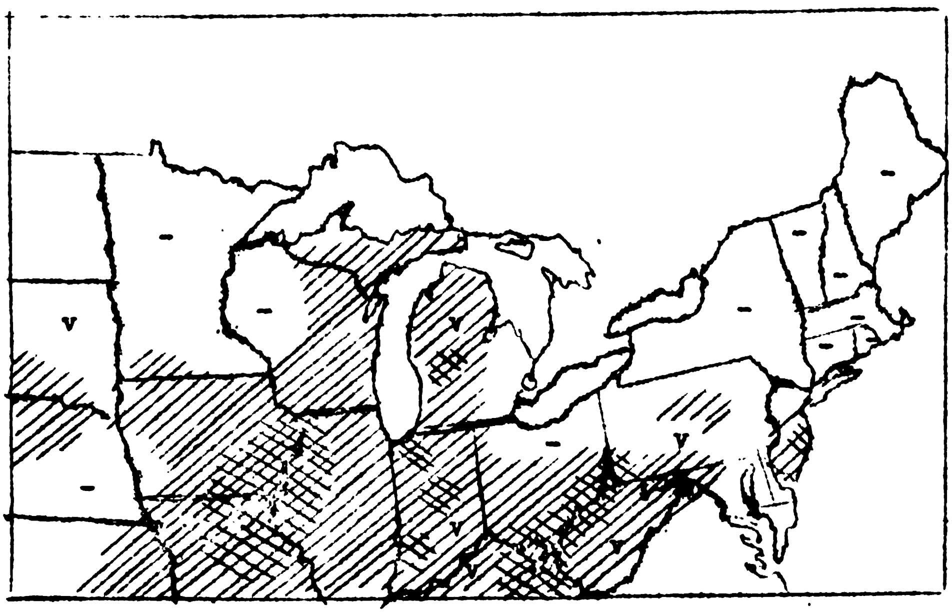
Washington: No authentic reports. (Dana).

Weather relations to early blight

From an analysis of conditions at Waupaca, Wisconsin in 1917, R. D. Rands[1] made the following summary of weather relations as they affect early blight epidemics:

> (1) "In order to have the optimum conditions for an epidemic there must be relatively high temperatures in combination with a more or less weakened condition of the plant so that the fungus can make its greatest spread.
>
> (2) "That such development will not occur unless the above conditions are prefaced by relatively moist periods of high humidity and abundant dew or rainy weather when spore production and infection can readily take place."

The prevalence of early blight (expressed by symbols in use in the Plant Disease Survey) is indicated by states, so far as data are at hand, on the accompanying maps of the United States (Figs. 67 and 68). It will be noted that the New England states, which has low rainfall in August and September, had but slight attacks of early blight, while the states that reported considerable loss - West Virginia, Kentucky, Tennessee, Michigan, Indiana,

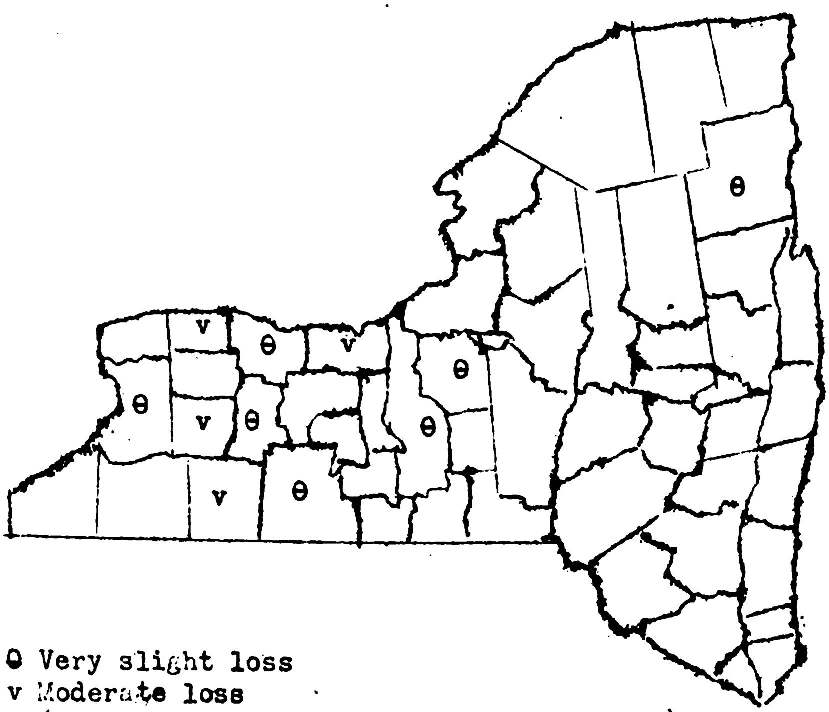


- Slight loss
v Moderate loss
4-6 inches
Over 6 inches

Fig. 67. Rainfall map for August, 1921 with early blight loss indicated. (Adapted from Nat. Weather and Crop Bul. series 1921[38]: Sept. 21, 1921.)

- Slight loss
v Moderate loss
//// 4-6 inches
XXXX Over 6 inches

Fig. 68. Rainfall map for September 1921 with early blight loss indicated. (Adapted from Nat. Weather and Crop Bul., series 1921[42]: 7. Oct. 19, 1921.)



θ Very slight loss
v Moderate loss
(Early blight was found in all counties)

Fig. 69. Early blight in New York, 1921. (Chupp).

Kansas, South Dakota, are for the most part those in which rainfall was most plentiful. From a comparison of these maps with the prevalence reports of early blight, especially when the high temperature conditions of 1921 are recalled, the accuracy of Rand's conclusions is apparently confirmed.

From a comparison of the accompanying map (Fig. 69) indicating the severity of early blight in New York, according to the results of the rather large number of field inspections in the state, with the rainfall map for September (Fig. 68), a correlation of the prevalence of early blight with late summer rainfall similar to that shown for the country in general is apparent for New York.

Reference

1. Rands, R. D. Early blight of potato and related plants. Wisconsin Res. Bul. 42: 486, p. 37. 1917.

Fusarium blight caused by Fusarium oxysporum Schlecht., and related organisms

Fusarium blight or wilt, typically known as a hot weather and warm soil disease, was especially prevalent last year in all sections except those where rainfall was plentiful. The reports available to the Survey are summarized in Table 46, and some of the more significant statements of collaborators and others are quoted below.

Western states: Fusarium wilt, blight and other diseases of this group always have been and remain a problem of the utmost importance in the West. While instances may be observed where infection is close to 100% we have no effective measure of control to offer. We have seen a good deal of sad conditions. Now we have practically reached the point where it is imperative for us to make a decisive transition into the domain of augmented experimental activities. The control measures for the Fusarium diseases should be studied from the view point of both the soil and the seed infection. It must be considered also that the Fusarium troubles of the potato plant are not caused by any single species of this fungus, as was once supposed, but by several species of this genus. It is quite probable, therefore, that the ultimate control measures may differ with the different species. (Shapovalov).

Washington: I think that disease conditions are worse in the Yakima Valley than they have been for a long time, especially on potatoes. Up to the present time, I have not considered that the Fusarium wilt was a factor in this state in disease work. The first field that I visited at Wapato, I found practically 99% Fusarium. (Zundel, August 23).

Upon closer observation, the Fusarium wilt in the Yakima Valley is probably the western field rot (Fusarium radicicola). (Zundel, September 3).

New York: The weather was hot and dry which seems to favor wilt. (Chupp).

Indiana: Many indications that disease arises primarily from soil rather than a seed infection. (Gardner).

Montana: Hot, dry July and August seemed to increase disease. (Jennison).

Table 46. Relative prevalence and importance of Fusarium wilt, F. oxysporum and related organisms, as reported by collaborators, 1921.

State	Prevalence compared with: Last year	Prevalence compared with: Average year	Importance	Losses	Nature of injury	Geographic range	Earliest appearance: Date	Earliest appearance: Place
Vt.			Unimportant	1-5%	"Gilbert reports occasional pronounced and severe cases."(Lutman)			
N. Y.	More	More	Rather imp.	1.5%	50% highest in any field (See Chupp's report)	Whole state	Aug. 20 July	Corinth Tompkins
Pa.	Same	Same		Not severe.	Found in warmest portion	Southeast section		
Md.				Trace				
Va.	More complaints					General		
Ky.	Same		Important	5%	20% of fields show 1-15%, maximum in field 15%			
N. C.				3%	Most destructive in early crop			
Miss.	Trace	Same		Trace	Important locally		May 8	Crystal Spr.
Ark.				2%				
Ohio		Same			Temperature and moisture favorable		July 9	Richland Co.
Ind.	Less	Less	Serious	.5%	Heat favored, cool August and September checked		Aug. 8	LaPorte Co.
Minn.	More			1%			Sept.20	Ramsey Co.
N. D.	Less	Less			Best results by selection and by stem-ending			
Nebr.				10%				
Mont.	More	More		2-3%	Especially severe in east			
Colo.	More	More					Aug.	Delta
Ida.	More		Important	5%	General, most severe in southern irrigated section			
Calif.				8%				

Colorado: Fusarium wilt, the chief and most serious disease has made its appearance in every field, The season is considerably advanced and there has been a prolonged hot spell, consequently the disease has already become well established. (Shapovalov, August 6).

Very prevalent and extremely bad in many individual cases. A few fields were a total failure on this account. (MacMillan, October 31).

Table 47. Losses caused by Fusarium wilt reported by collaborators; with yields as given by the Bureau of Markets and Crop Estimates. (Monthly Crop Reporter 7: 154. Dec. 1921.)

State	Percentage reduction in yield	Production December 1921 crop estimates (Bushels)	State	Percentage reduction in yield	Production December 1921 crop estimates (Bushels)
N. Y.	1.5	33,990,000	Minn.	1.0	27,525,000
Pa.	3.0	21,586,000	Nebr.	10.0	8,160,000
Ky.	5.0	3,770,000	Mont.	2-3	5,060,000
Miss.	Trace	1,088,000	Colo.	3.0	11,070,000
Ark.	2.0	1,815,000	Ida.	5.0	10,545,000
Ohio	4.0	6,728,000	Calif.	8.0	10,064,000
Ind.	.5	3,570,000			

Special reports

Table 48. Percentages of Fusarium wilt in potato fields in Nebraska as shown by field inspections, 1921. (Goss and Werner).

County	Number of fields inspected	Acreage	Variety	Average percentage Fusarium wilt
Box Butte	12	442	Triumph	5.33
	2	31	Early Ohio	1.75
Dawes	9	86.5	Triumph	.49
	3	11.5	Early Ohio	2.03
Kimball	10	170	Triumph	4.67
Scotts Bluff	1	11	Triumph	1.00
	1	10	McClure	10.00
	1	7	Early Ohio	3.00
Sioux	2	22	Early Ohio	.50
Total and average	41	791		3.20

Wart caused by Chrysophlyctis endobiotica Schilb.

Wart continues to be regarded as a disease of major importance both abroad and in the United States. Results of surveys showing the narrowly

restricted distribution in America, and reports of strict and efficient quarantines have reassured growers and workers as to the American situation. The great extension of the disease in England and Scotland[2] due to the effects of the war on trade movements, and the extensive tests of varietal resistance[1] are worthy of note by those interested. The fact that no varieties of the Rural group are immune makes potato wart have particularly dangerous significance to the American potato growing industry. The following statement by Weiss and Orton[3] of experimental work in the United States summarizes the results of federal and state investigations.

> "Potato and tomato remain the only demonstrated American hosts. Seven additional varieties of American potatoes are provisionally classed as immune, making 34 in all out of 103 varieties tested, but the number of types of immune potatoes remains the same; namely, McCormick, Green Mountain, Cobbler, Spaulding Rose, Ehnola, and Burbank, while the Rural New Yorker, Early Ohio, Early Rose, Triumph, Early Michigan, Pearl, and Up-to-date types are susceptible. Eggplant, cayenne and pimento peppers, petunia, tobacoo, Datura sp., Solanum integrifolium, and S. carolinense are not susceptible to wart disease. S. nigrum and S. dulcamara have never been found infected in America. Infection of highly susceptible varieties occurred in June during heighth of growth, but in general both infection and development of tumors were retarded by dry soil or high temperatures. In controlled soil temperature experiments infection occurred at 22°C., which is above optimum for growth of potato."

The 1921 potato wart survey

The status of survey work on this disease is presented thus by G. R. Lyman and G. Hamilton Martin, Jr.

> "The intensive survey of suspicious areas in Pennsylvania, West Virginia, and Maryland, initiated in 1919, continued in 1920 by the Plant Disease Survey acting for the Federal Horticultural Board and with the Experiment Station authorities of the states concerned, was further carried on by seven field assistants in 1921. The field work of the 1921 survey began at Freeland, Pennsylvania July 7 and ended on August 27.
>
> "The survey was confined to Pennsylvania, West Virginia, and Maryland, the three states within whose borders wart was already known to exist. No new findings were made in West Virginia. Unimportant extensions of the territory known to be infested were made in Pennsylvania by field men of the State Department of Agriculture. In Maryland, field men, cooperating with officials of the State Agricultural Experiment Station at College Park, thoroughly surveyed the coal districts of Allegany and Garrett Counties and found wart in three new towns, making six towns in that region now known to be infested.
>
> "Pennsylvania: This year's work completed the survey of the bituminous mining districts in western Pennsylvania where wart seems most likely to have become established. Many industrial towns were also surveyed in the counties visited, together with a number of lumbering settlements. No additional areas of infestation were found either by the Federal inspection party or by the field men of

the Pennsylvania Department of Agriculture. State officials, however, found a single case of wart at White Haven in the Hazelton district, which had been included in the quarantined areas under suspicion, although no wart had ever been found there. In western Pennsylvania a state quarantine officer found wart in the town of Onnalinda in the immediate neighborhood of Beaverdale and Llanfair, which places were already known to be infested.

"With the close of the year's survey all the areas in Pennsylvania have been covered which, from our past experience, would appear to be especially suspicious. Further survey work on the past season's basis would seem to be unwarranted, though the quarantine officials must be on the watch for sporadic cases which may have escaped detection by the survey groups.

Table 49. Present known distribution of wart in the United States, 1921. (G. Hamilton Martin, Jr.).

Town	County	State	No. of infested gardens known	Date of discovery	Discovered by
Nanty Glo	Cambria	Pa.	2	8-27-19	Plant Disease Survey men
Lilly	"	"	1	9-13-19	" " " "
Llanfair	"	"	12	9-23-19	" " " "
Osceola Mills	Clearfield	"	5	10-8-19	" " " "
Vintondale	Cambria	"	2	10-8-19	" " " "
Clarence (Snow Shoe)	Center	"	2	10-14-19	" " " "
Woodvale	Huntingdon	"	2	7-29-20	" " " "
Robertsdale	"	"	7	8-3-20	" " " "
Janesville (Smithmill)	Clearfield	"	2	9-1-20	" " " "
Beaverdale	Cambria	"	1	8-18-20	Pennsylvania State men
Yatesboro	Armstrong	"	3	-----20	" " "
Onnalinda	Cambria	"	15	-----21	" " "
White Haven	Luzerne	"	1	-----21	" " "
Whitmer	Randolph	W.Va.	2	9-9-19	Plant Disease Survey men
Thomas	Tucker	"	21	9-12-19	" " " "
Coketown	"	"	2	-----20	West Virginia State men
Pierce	"	"	2	-----20	" " " "
Lord	Allegany	Md.	1	9-15-20	Plant Disease Survey men
Mt. Savage	"	"	4	9-19-20	" " " "
Eckhart Mines	"	"	2	9-21-20	" " " "
Detmold	"	"	3	8-5-21)	Plant Disease Survey and
Charlestown	"	"	1	8-10-21)	Maryland State party
Midland	"	"	1	8-10-21)	

"West Virginia: The southern West Virginia coal fields were thought worthy of further attention on account of the constant migration of miners between the northern and southern coal fields and also on account of the railroad down the Greenbrier Valley which affords an opportunity for constant communication between the two parts of the state. A few suspicious localities in the northern section also required attention.

"No wart was found, all suspicious cases reported proving to be severe scab infection, although conditions in many of the gardens visited appeared to be favorable for the development of wart."

"Maryland: The coal areas of Maryland are confined to Garrett and Allegany Counties in the western end of the state. This region was rapidly surveyed by our field assistant in 1920 and wart found in three towns, - Lord, Mt. Savage, and Eckhart Mines, one infested garden being discovered in each town. In 1921 all mining villages and communities in Allegany and Garrett Counties were visited together with a number of neighboring farming communities.

"Wart was discovered at Detmold on August 5, at Charlestown and Midland on August 10, Eckhart Mines on August 11, and at Mt. Savage on August 23. Wart was first discovered at Eckhart Mines and Mt. Savage last year, but was found this year in new gardens on the dates mentioned.

"Wart is now known in six mining towns with a total of twelve infested gardens as follows: Lord, one garden; Mt. Savage, four gardens; Eckhart Mines, two gardens; Detmold, three gardens; Charlestown, one garden; and Midland, one garden. It is reasonably certain that wart is also present in a number of other localities. This can be determined only by future search."

Importance of the Maryland situation

"In certain respects conditions in Maryland differ from those generally present in the infested districts of Pennsylvania and West Virginia, and there appears to be greater danger of the disease spreading to new territory. In considering the Maryland situation the following facts should be borne in mind.

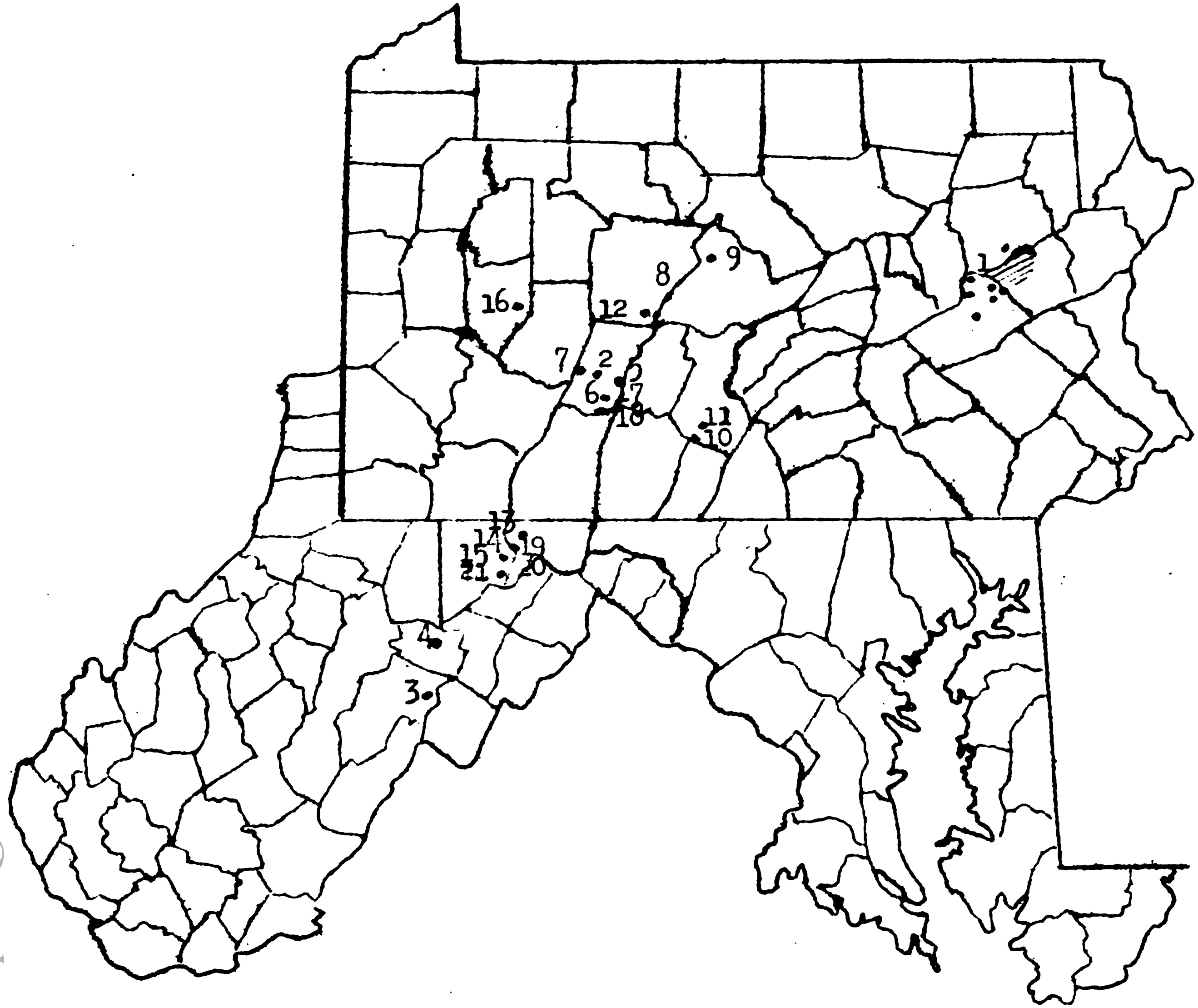
"(a) Seed potatoes are extensively grown in this region and certain seed potato fields at Eckhart Mines lie only a short distance from infested gardens.

"(b) The wart infested villages are not isolated from farms by uncultivated lands, but in many cases are immediately surrounded by tilled fields. Therefore, there is grave danger that the disease may spread from miners' gardens to neighboring farm lands.

"(c) The people are largely Americans who have lived in that region for generations. In the case of many families, certain members are farmers and others miners. The constant intercourse between the various members of such a family greatly increases the danger of wart spreading from gardens where it is now known.

"(d) The infested region is not isolated, but is readily accessible by the National Pike from Cumberland, the Westernport Pike from Westernport and Piedmont, and by electric railways from Cumberland and Westernport.

"(e) The infested villages are but a short distance removed



LEGEND

1. Original Eastern Pa. area
2. Nanty Glo
3. Whitmer
4. Thomas
5. Lilly
6. Llanfair
7. Vintondale
8. Osceola Mills
9. Clarence
10. Woodvale
11. Robertsdale
12. Smithmill
13. Mount Savage
14. Eckhart Mines
15. Lord
16. Yatesboro
17. Beaverdale
18. Onnalinda
19. Midland
20. Charlestown
21. Detmold

Fig. 70. Known distribution of potato wart in the United States, 1921.

from the Pennsylvania state line on the north and the West Virginia line on the south."

In Maryland, therefore, survey work must be emphasized, and we must look to State authorities there to inaugurate a strong, effective quarantine to protect the adjoining districts.

References

1. Collins, E. J. The problem of the inheritance of immunity to wart disease in the potato. Gard. Chron. III, 70: 260, 271. Illus. Nov. 19, 26, 1921.
2. Taylor, H. V. The distribution of wart disease (cont'd). Jour. Min. Agr. Gt. Brit. 27: 946-953. Jan. 1921.
3. Weiss, F. and C. R. Orton. Progress notes on potato wart disease investigations. (Abstract) Phytopath. 12: 38. Jan. 1922.

Rhizoctonia disease caused by Corticium vagum Berk. and Curtis

Rhizoctonia, which caused damage by decimating stands, cankering stems and stolons, causing rot of feeding roots (Minnesota), and blemishing tubers, was an important disease in many states, as is shown by the accompanying table (Table 50) compiled from collaborators' reports; and the quotations below.

Table 50. Percentage losses caused by Rhizoctonia disease of potato, as estimated by collaborators, 1921.

State	Estimated percentage loss	State	Estimated percentage loss
Vermont	.5-1%	Indiana	0.2
New York	1.5	Michigan	5.
New Jersey	3.	Wisconsin	0.1
Pennsylvania	3.	Minnesota	1.
Maryland	3.	Iowa	6.
Virginia	2.	North Dakota	0.1
West Virginia	Trace	South Dakota	2-5
Kentucky	5.	Nebraska	3-5% infection
Tennessee	1.	Kansas	15.
North Carolina	6.	Montana	2.
Georgia	1.	Utah	2.5
Mississippi	Trace	Idaho	7-8
Louisiana	Rare	Washington	8.
Texas	Trace - 1	Oregon	8.
Arkansas	Trace - 3	California	8.

Vermont: More serious than usual, resulting in many missing hills early in the season; 10 to 15% in some fields. (A. H. Gilbert).

New York: The first appearance recorded was June 6 in Suffolk County. No varieties were resistant, and Cobblers were probably most susceptible. (Chupp).

New Jersey: Less than last year; 5% of plantings in state were infested. (Cook).

Pennsylvania: General. (Thurston and Orton).

Virginia: Norfolk County. Occasional plants affected with Rhizoctonia were found, probably not more than 1-2% on the average. (Fromme).

Kentucky: Important, causing 5% reduction in yield for the state. Found only in early crop, doing injury to underground stems. (Valleau).

South Carolina: Present in abundance on northern seed shipped in for planting the early crop. May have been contributing cause for a rot of seed pieces in the ground with consequent failure of plants to come up in Charleston County. (Ludwig).

Florida: Especially noticed in the Hastings district. The seed planted was said to be certified. (Burger).

Mississippi: Unimportant. (Neal).

Louisiana: Rarely occurs. (Edgerton).

Texas: Prevalent, 1% loss. (Taubenhaus).

Arkansas: Of little or no importance. (Elliott).

Indiana: Worse than last year or the average year. (Gardner).

Wisconsin: Less than for several years, apparently associated with high soil temperature. Seed treatments with corrosive sublimate proved very effective. Not any appreciable reduction of stand this year. (Vaughan).

North Dakota: At present it seems likely to be the chief bar to extensive potato certification. (Bolley, October 15).
One of our most serious diseases. (Couey).

South Dakota: In most localities. (Evans).
Our worst infectious potato disease. (Petry).

Nebraska: (See Table 51).

Kansas: Worse than usual, causing at least 15% reduction in yield. Attacked stems underground causing missing hills and weak plants. Occurred in every potato patch. First appeared May 2, in Wyandotte County. Cool, wet spring; cooler than usual. Twenty-two hundred acres treated as a result of demonstrations covering a

period of 3 years. Average increase in yield due to treatment, 19 bushels. (Stokdyk).

Table 51. Percentages of Rhizoctonia in potato fields inspected in Nebraska, 1921. (Goss and Werner).

County	Number of fields inspected	Acreage	Variety	Average percentage Rhizoctonia
Box Butte	14	469	Triumph	2.54
	2	31	Early Ohio	5.00
Dawes	13	169	Triumph	.78
	4	16.5	Early Ohio	4.00
Kimball	8	147	Triumph	2.41
Sioux	4	56	Triumph	1.12
	1	3	Downing	1.00
Scotts Bluff	1	10	McClure	t
	1	7	Early Ohio	1.00
	1	11	Triumph	t
Total and average	49	919		1.88

Western States: Rhizoctonia disease under certain seasonal conditions becomes very active in the West, as has been the case this year. It should be learned why and how this occurrence takes place and what can be done to prevent the losses. (Shapovalov).

Montana: Very common and widespread. (Jennison).

Colorado: In some cases it has prevented seed certification. (Learn).
As the season progressed Rhizoctonia developed and did about 15% of the total damage incurred in the Greeley district. (MacMillan).

Arizona: Most serious with Peerless. (Brown).

Washington: More trouble this year than usual. I find that potatoes planted from the latter part of April up to and including the middle of May are diseased, ranging as high as 80% Rhizoctonia. Potatoes planted after May 15 and up to and including the fore part of June show very little disease. (Zundel).

Oregon: Probably same as usual; our most prevalent and destructive disease. Fifty percent of plants in some fields dying. Caused blight of stolons and roots and stem base. Coextensive with host. First reported June 4, from Hillsboro. Corrosive sublimate gives excellent control where soil is clean. (Barss).

California: Very severe in Delta region. (Milbrath).

Scab caused by Actinomyces scabies (Thax.) Güssow

This disease, now generally recognized as influenced profoundly by

soil reaction, soil infestation, cleanness of seed, and rate of growth of tubers, was reported generally from eastern United States but is known through survey records from every state. Although seven states report the disease as more severe, no striking effects of hot weather were noted by collaborators, doubtless such relations being masked by the other factors influencing prevalence.

Table 52. Reports on relative prevalence of scab during 1921.

Prevalence of scab	States
More	New York, New Jersey, Maryland, Arkansas, Indiana, Wisconsin, North Dakota, South Dakota, Washington.
Usual	Pennsylvania, Ohio, Michigan, Minnesota, Iowa, Idaho, Colorado, Oregon (probably).
Less	West Virginia, Mississippi.

Table 53. Losses from potato scab in 1921 as reported by collaborators. (Crop estimates from Monthly Crop Reporter, December 1921.)

State	Amount of disease	Size of crop, bushels. December, 1921, estimate
New York	1%	33,990,000
New Jersey	Very severe in early crop	9,025,000
Maryland	3%	3,185,000
Mississippi	5%	1,088,000
Arkansas	5%, fairly serious	1,815,000
Ohio	2%	6,728,000
Indiana	Considerable	3,570,000
Wisconsin	5%, ngeneral	21,420,000
Minnesota	1%	27,525,000
Iowa	6%	4,128,000
South Dakota	5%	4,400,000
Oregon	Not very important	3,870,000
California	3% (2% spring crop, 4% southern California)	10,064,000

The following tabulations of figures, obtained during field inspections in New York and Nebraska are included to show the importance of scab and to record some unusually high percentages met with in certain fields. The data are too meagre to allow any generalization as to reasons for the high percentages in certain counties, but more intensive work along this promising line would doubtless show strong correlation with some of the factors influencing scab. It should be said that not all of the seed used in these fields was treated, nor was it all certified seed.

New York: I have been down on Long Island the past week and have inquired about the prevalence of potato scab there during 1921. I

find that scab was very generally prevalent over the Island and that the losses resulting from it have been estimated by a committee to amount to $500,000. This may be inaccurate in a way but probably represents in a relative way the losses due to this disease. (M. F. Barrus).

Table 54. Percentages of scab in potato fields inspected in New York during the summer of 1921. (Barrus and Chupp).

County	Number of fields inspected	Acreage	Average percentage of scab
Allegany	18	59.00	1.30
Cayuga	17	54.50	0.35
Chenango	5	12.75	0.63
Clinton	9	42.50	0.43
Cortland	45	176.75	2.26
Erie	28	62.00	5.22
Essex	5	18.50	0.01
Franklin	48	188.01	1.49
Genesee	9	102.50	3.51
Livingston	7	37.50	2.63
Madison	3	6.00	1.17
Monroe	41	186.30	4.72
Niagara	4	6.75	34.78
Oneida	19	55.83	18.79
Onondaga	22	83.33	1.79
Ontario	15	64.16	9.01
Orleans	7	45.00	16.40
Oswego	8	25.00	3.25
Seneca	9	39.75	11.17
Steuben	10	53.50	2.81
Washington	75	170.15	Trace
Wayne	11	23.00	4.70
Wyoming	11	27.00	0.30
Total	426	1539.78	3.81

Table 55. Percentages of common scab in potato fields inspected in Nebraska, 1921. (Goss and Werner).

County	Number of fields inspected	Acreage	Variety	Average percentage common scab
Box Butte	10	377	Triumph	13.50
	1	6	Early Ohio	30.00
Dawes	3	53.5	Triumph	1.53
Kimball	2	80	Triumph	1.15
Scotts Bluff	1	7	Early Ohio	2.00
	1	11	Triumph	5.00
Sioux	3	52	Triumph	1.33
Total and average	21	586.5		8.71

Varietal susceptibility

The following reports concerning the susceptibility of varieties were received from collaborators:

New York: American Giants said to be less susceptible Washington County, where only American Giants are grown, shows only a trace of scab. (Chupp).

Wisconsin: Less on Rural New Yorker than other varieties. (Vaughan).

J. W. Brann and R. E. Vaughan[1] give the following table based on tests conducted at the Wisconsin Experiment Station.

Table 56. Occurrence of scab on six leading Wisconsin varieties. (Brann and Vaughan[1]).

	Average percent of scab		Average percent of scab
Late varieties		Early varieties	
Rural New Yorker	24	Early Ohio	44
Burbank	32	Triumph	51
Green Mountain	40	Irish Cobbler	62

Michigan: Russet Rural (Late Petoskey) is notably scab resistant. (Kotila).

Minnesota: Russet Burbank is affected but slightly by scab. (Stakman).

Control of scab

1. Sulfur treatment of soil

Interest in sulfur treatments for scab continues and while the applicability of this method is limited to those areas where potatoes are grown intensively and the use of sulfur almost takes the role of a fertilizer application, or where limestone soils make the raising of clean potatoes impossible without acidulation of the soil, it is to be hoped that this promising treatment will be extensively tried, using ordinary sulfur, finely ground sulfur, and inoculated sulfur.

As a seed treatment device, it is suggested that the time element be considered and that the old experiments of Halsted, in which tubers are rolled in sulfur, be repeated, using the sulfur some months in advance of planting in order that oxidation may take place.

Collaborators' comments on the results of the use of sulfur soil treatments are given below:

Connecticut: Benefit from 600 pounds sulfur per acre in scabby land reported. (Clinton).

New York: Sulfur use becoming common in Nassau County. (Chupp).

New Jersey: The results of experiments on the use of sulfur in various forms as a means of controlling scab have been reported by W. H. Martin in various articles. (See references 3-8 in list below.)

Table 57. Results of experiments in New Jersey with sulfur on potato soils.[3] (W. H. Martin).

Soil treatment	Percent of clean tubers
Average of six tests:	
Untreated soil	8.9
600 lbs. inoculated sulfur	50.9
600 lbs. uninoculated sulfur	33.5
Average of three tests:	
300 lbs. inoculated sulfur	45.7
600 lbs. uninoculated sulfur	39.2

Indiana: C. T. Gregory reports no control with sulfur, 660 pounds per acre in Lake County. (Gardner).

Michigan: No consistent results as yet with sulfur on calcareous soil in Upper Peninsula. Experiments being continued. (Coons).

Wisconsin: We tried out the Bac-sul on a medium heavy loam in Chippewa County and on a light sandy loam in Burnett County. The result of both tests showed no advantage in the use of the sulfur. In fact, there was slightly more scab where sulfur was used, which may be explained on the ground that the soil was not uniformly infested with the scab organism. This experience confirms the experience which we had in 1920. (Vaughan).

2. Other methods

Mississippi: Many are culling and treating seed. (Neal).

Arkansas: Treatment has given negative results. (Elliott).

Michigan: The scab organism is but another plant which can be looked upon as an indicator...... Those soils where clover occurs as a native, and where inoculation is unnecessary, are commonly soils where potato scab is excessive and where seed treatments for scab are uncertain in their results. (Coons[2])

Wisconsin: Both corrosive sublimate and formaldehyde reduced scab decidedly. Corrosive sublimate, however, proved the more effective. (Brann and Vaughan[1]).

Western States: Continued observations and experiments have demonstrated that no standard or uniform potato seed treatment with

mercuric chloride can be relied upon to give beneficial results upon certain types of alkaline soils. On some soils treatment results in positive harm to the seed potatoes as compared with untreated control plots. Treatments have to be worked out and modified to meet local soil and water conditions. Formaldehyde is non-effectual against common scab under irrigation where mismanagement in the use of water may cause an excess of soil moisture for an extended period at any time during the early stages of tuber development. Steadily growing plants, either treated or untreated, maintained free from excesses of drought or moisture appear to escape disease a longer time than where improper application of water has occurred. (MacMillan, H. G. Potato seed treatments in western states. (Abstract) Phytopath. 12: 39. Jan. 1922.)

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Blackleg caused by Bacillus phytophthorus Appel

From the reports of collaborators it would seem that while blackleg in general, is a cool climate disease and distributed largely in the northern parts of the country, it has strong capabilities for persistence and its period of appearance is correlated with heavy rainfall. In Michigan, Wisconsin, and Minnesota the early damping-off phase was largely absent, but the

disease developed in the fall to some extent. In sharp contrast to the mild form of decay in Minnesota is the heavy decay according to inspection reports in North Dakota. The weather for August in North Dakota, where blackleg appeared between August 15 and September 1, is of great interest in this connection, the following being the official summary[2]:

> "The temperature and precipitation for the month averaged near the normal, the former being slightly above and the latter slightly below the normal. The first decade was the driest and during this period harvesting of small grain was practically completed. The ground, however, was mostly too dry for fall plowing and late planted potatoes suffered. The second decade was the coolest of the month and frequent showers, in many instances quite heavy, relieved the drouth conditions. The third decade was the warmest as well as the wettest and at the close of the month the ground was generally in excellent condition. The mean temperature was 60.2° or 1.8° above the normal."

Field decay in the Western States, previously obscurely known, has been thought to be the result of attacks of a variety of organisms. The form of rot on Netted Gem is typical of the manifestation in the East, the decay taking various forms which simulate other western potato decays.

Shapovalov and Edson[1] have isolated Bacillus phytophthorus from many affected tubers and proved its pathogenicity, and ability to produce the typical disease.

Dates of earliest appearance of blackleg, 1921

April 2...	California, Colma
May 5-20..	Indiana, Marion County
May 31....	Ohio, southern
June 6....	New York, Suffolk County
June 9....	Connecticut, Cromwell
July 25.....	Minnesota, Polk County
August......	Colorado, Delta
August 2....	Wisconsin
August 8-15.	North Dakota

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Mosaic (cause undetermined)

Potato mosaic continues to be of great interest to workers in plant pathology, mosaic problems at present occupying the attention of many investigators. Results of experimental work conducted in the Office of Cotton, Truck, and Forage Crop Disease Investigations throw much light on the puzzle and undoubtedly have great significance in potato certification work. The former

attitude of allowing a fairly high tolerance of mosaic and leaf roll of potatoes (2-5%) in a field inspected for certification, is now being questioned. The following quotation is from a letter distributed to men interested in potato certification by the Office of Cotton, Truck, and Forage Crop Disease Investigations:

"Dissatisfaction with present standards of certification has been manifested before in reports of southern state workers dealing with the behavior of northern seed under their conditions."

In this connection the following statement made by Edgerton and Tiebout[3] in a bulletin of the Louisiana Station, is also noteworthy:

"All of the results show definitely that a greater consideration must be given the mosaic disease by the northern growers of certified seed if they expect to make this seed popular in the southern states."

Interesting developments are presaged by fragmentary reports coming from different stations dealing with the selection and increase of either clean or resistant varieties. The work of Blodgett[2] and his associates at New York in developing the index system gives promise, although the matter is not so simple as one might suppose without investigation.

"The outstanding result of this year was that practically all potatoes thus indexed as being affected with mosaic failed to show symptoms of the disease in the field under conditions prevailing in New York State this year. This result would seem to indicate the general unreliability of counts made on mosaic and the importance of removing mosaic plants by roguing under such conditions."

Blodgett[1] also reports negative results in an attempt to kill potato mosaic virus with hot water treatment from 35-80°C. This is taken to indicate that in the range in temperature used, the time necessary to kill the mosaic virus is longer than that for the killing of the potatoes. Perennial solanaceous plants are mentioned by Melhus[5] and by Gardner and Kendrick[4] as potential reservoirs of the virus.

The following are the comments from collaborators on this disease:

New Hampshire: Not as prevalent this year as last. (Butler).

Vermont: Apparently less than last year but this loss is undoubtedly deceptive as it was very difficult to diagnose with the extreme hot weather. Since it has become cooler, some fields that were apparently free from mosaic are showing it. (Lutman).

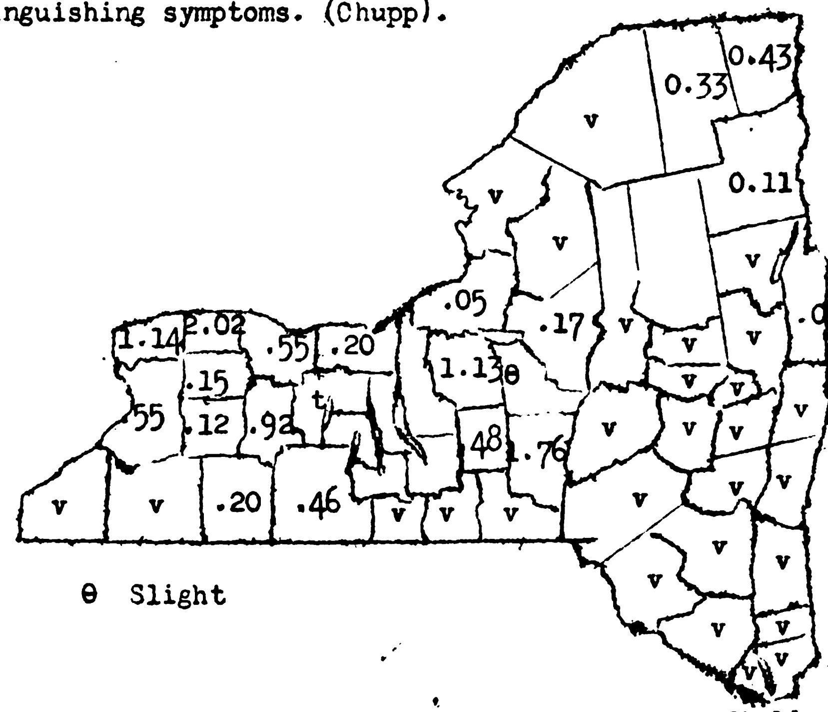
None to 10% in inspected fields, with occasional fields running as high as 15-25%. (Gilbert).

Massachusetts: Very severe in some cases, but generally not important where selected northern grown seed was used. (Osmun).

Rhode Island: Very little observed. (Browning).

Connecticut: Probably less than usual. (Clinton).

New York: Reduction in yield wherever potatoes are grown, especially in "white sprout" areas. Extremely bright sunshine masked many of the distinguishing symptoms. (Chupp).



v Moderate θ Slight

Fig. 71. Average percentage of mosaic found in New York fields during inspection, summer of 1921. (Chupp).

New Jersey: Less than usual, reduction in yield for state 5%. (Cook).

Pennsylvania: As prevalent as usual, most important in northern counties; 1% reduction in yield. Green Mountain and Spaulding Rose most susceptible varieties. (Thurston and Orton).

Virginia: Of slight importance in western part of state, no observations made in eastern section. (Fromme).

West Virginia: No cases observed. (Giddings).

Kentucky: Minnesota certified seed was grown to a slight extent in spring and rather extensively in fall near Louisville. More than doubled common stock in yield and was slightly better than best Louisville stock. (Valleau).

North Carolina: The average infection in the early crop would probably be between 10 and 15%, but in some instances the infection was as much as 50%. Another disease which growers have not recognized as specific and hence do not realize the importance of its control. This disease is being introduced every year through seed purchased from the north. (Foster).

Avery County: Distinct symptoms of mosaic were absent, and it is a significant fact that aphids were also practically absent. (Shapovalov, News Notes, Office of Cotton, Truck, and Forage Crop Disease Investigations. Aug. 6, 1921, page 5.)

South Carolina: Unimportant. (Ludwig).

Florida: Mosaic was prevalent in the Hastings section. In one field of 27 acres the yield was cut to about 20 barrels per acre. The seed came from Maine and was said to be certified. (Burger).

Mississippi: Mosaic continues to be the dominant potato disease in the state. It occurred in about the same amount as last season. Bliss Triumph stock continues to develop a heavy percentage of infection. Observed and reported about the middle of May in practically all the trucking centers in south Mississippi. (Neal).

Louisiana: Very common on Bliss Triumph, causing very serious loss. Disease was particularly bad on potatoes grown from certified seed in the Alexandria district. Growers lost at least $15,000 by using this seed. Loss caused by this disease on Triumph variety all over the state from 25-75%. (Edgerton, August 1).

Arkansas: Always important. One hundred percent of fields in state infested, showing 5% affected plants. Reduction in yield for state 10%. It was first reported in June from Fayetteville, but later occurred all over the state. Bliss Triumph was very susceptible. (Elliott).

Indiana: A low percentage of the stand affected. Not considered a serious factor in Indiana. (Gardner).

Michigan: Probably, quite as usual. The mosaic in all early stock was easily overlooked because of the masking effect of the vigorous growth brought about by the season. In late Green Mountain potatoes, only one field was able to pass inspection, which permitted no more than 4% mosaic. (Coons).

Wisconsin: Triumph, most susceptible; Green Mountain, medium; Cobblers, Ohio, Burbank, and Peerless, slight; Rural New Yorker, little if any. Symptoms may have been masked by dry weather. Notably less aphis than usual this year, which seems important. (Vaughan).

Minnesota: Largely obscured by dry weather and leaf hopper injury. About as abundant as in previous years. (Department of Plant Pathology).

Iowa: More. Found in Early Ohio and Bliss Triumph. (Melhus).

North Dakota: This disease has not been pronounced in North Dakota this year. (Bolley).

Nebraska: Slight amount of mosaic in western potato sections. (Goss).

Kansas: Slight amount in plants from northern seed (Bliss Triumph). (Melchers).

Western States: Mosaic has now reached such a degree of prevalence

throughout the Western states that, if neglected, neither reasonable yields nor any substantial progress in the seed improvement work can be expected. We have now definitely established that it reduces the yield in the West exactly in the same proportion as it does in the East, that is on the average by one-third. It is evident also that in a number of successive years the diseased plants are apt to go from bad to worse, especially under adverse seasonal or poor cultural conditions. We have no exact knowledge, however, as to the principal agencies transmitting this disease in the West. Likewise, we lack exact experimental data on which to base our recommendations for control, except what we have learned in the East. (Shapovalov).

Montana: Very common and widespread throughout the state. Innumerable "mild cases" appearing during early September and late August. Taken as indication of frequent transmission and rapid spread of the disease through mid-summer weeks. (Jennison).

Colorado: (Montrose section). Mosaic was noted, though no pronounced cases. (Shapovalov, News Notes, Office of Cotton, Truck, and Forage Crop Disease Investigations, Aug. 6, 1921, page 5.).

Utah: Especially severe throughout the state. Many fields exhibited as high as 50-60%. No fields were found free. Cache and Boxelder Counties appear to have suffered most severely from the trouble. It would be safe to state that Utah's crop was reduced from 15-25% from what appears to be the typical mosaic of the East. (Richards).

Idaho: Potato mosaic is becoming of increasing importance each year in Idaho. Especially bad in North Idaho this year. (Hungerford).
Common in southern part of state, varying from trace to 100%. Present in every field inspected. (Raeder).

Oregon: Apparently of considerable importance, coextensive with host; more than 90% in some fields. Observations this year show disease to be widespread and serious but extent of yield reduction not determined. (Barss).

California: Mosaic occurred in all districts south of San Francisco and Sacramento. All fields showed this disease in some degree. Owing to the association of other diseases it is difficult to estimate the effect on the crop. (Milbrath).

Losses from mosaic, 1921

Figures from New York inspections (Table 59) made available to the Plant Disease Survey through the courtesy of Barrus and Chupp (Cornell University) are here reproduced as illustrating typical conditions in the northeastern part of the country where mosaic was important in practically all fields, but where its symptoms were masked by weather and hopper-burn. The figures from the inspections in Nebraska are also of interest (Table 60).

Table 58. Estimated reduction in yield of potatoes due to mosaic, as reported by collaborators, 1921.

State	Estimated reduction in yield due to mosaic	State	Estimated reduction in yield due to mosaic
Vermont	5-10%	Arkansas	10%
New York	1.5%	Indiana	0.1%
New Jersey	5%	Michigan	t
Pennsylvania	1%	Wisconsin	t
Delaware	0.5%	South Dakota	t
Virginia	1%	Montana	10%
Kentucky	40% in early crop, less in late	Utah	12%
		Idaho	3%
North Carolina	2%	Washington	15%
Louisiana	30%, very serious	Oregon	1%
Mississippi	15%	California	.5%
Texas	0.1%		

Table 59. Percentages of mosaic in potato fields inspected in New York during the summer of 1921.

County	Number of fields inspected	Acreage	Average percentage of mosaic
Allegany	18	59.00	4.50
Cayuga	17	54.50	2.12
Chenango	5	12.75	0.19
Clinton	9	42.50	2.11
Cortland	45	176.75	0.16
Erie	28	62.00	0.07
Essex	5	18.50	4.13
Franklin	48	188.01	3.38
Genesee	9	102.50	0.28
Livingston	7	37.50	0.92
Madison	3	6.00	Trace
Monroe	41	186.30	0.06
Niagara	4	6.75	0.00
Oneida	19	55.83	0.49
Onondaga	22	83.33	0.03
Ontario	15	64.16	0.36
Orleans	7	45.00	0.07
Oswego	8	25.00	0.80
Seneca	9	39.75	Trace
Steuben	10	53.50	0.95
Washington	75	170.15	1.73
Wayne	11	23.00	Trace
Wyoming	11	27.00	0.11
Total	426	1539.78	1.11

Table 60. Percentages of mosaic in potato fields inspected in Nebraska, 1921. (Goss and Werner).

County	Number of fields inspected	Acreage	Variety	Average percentage mosaic
Box Butte	14	469	Triumph	1.38
Dawes	18	213.5	Triumph	5.92
	4	16.5	Early Ohio	1.38
Kimball	3	40	Triumph	0.00
Scotts Bluff	1	10	McClure	t
Sioux	1	2	Downing	t
	4	56	Triumph	.75
Sheridan	1	7	Early Ohio	t
Total and average	46	814		2.92

Dates of first indications of potato mosaic, 1921

March.... Louisiana, Baton Rouge
May...... Mississippi, Crystal Springs
June..... Arkansas, Fayetteville
June 4... Oregon, Hillsboro
June 6..... New York, Suffolk County
July 19.... Wisconsin, McNaughton
Sept. 27... Delaware, Bridgeville

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Leafroll (cause undetermined)

Leafroll continued in 1921 to be a disease of major importance and the subject of considerable research. In the summary of their very important contribution to our knowledge of leafroll, Schultz and Folsom[2] make the following significant statements:

"Leafroll is transmissible from one plant to another by means of grafting either tubers or stalks and by means of aphids.

"Net-necrosis is apparently a leafroll symptom..... It develops in the dormant tubers without relation to differences in the storage temperature. When it occurs as a symptom of leafroll, the effects of the latter are still more detrimental, one being a decided spindliness of the sprouts. Transmission and control of leafroll are thus concerned indirectly with net-necrosis and spindling sprout.

"Leafroll and mosaic are somewhat similar types of diseases.

"Inter-regional differences in the spread of leafroll may depend upon differences in climate and in the abundance of aphids.

"Roguing has proved to be more effective in eliminating leafroll than it has been for mosaic, at least in northeastern Maine."

The results of the investigations of Schultz and Folsom, in so far as they deal with the correlation of foliage degeneration and leafroll, have been supplemented by A. H. Gilbert[1] who presents confirmatory work.

"(1) Tubers with spindling sprouts invariably produced either leafroll plants or plants possessing both mosaic and leafroll symptoms.

"(2) Spindliness of sprout was often correlated also with net-necrosis. Eyes in or near necrotic tissue produced spindling sprouts, while other eyes from non-necrotic portions of the same tuber produced sprouts apparently normal. No disease-free plants, however, were secured from tubers either partially or entirely necrotic.

"(3) Every net-necrosis tuber produced plants showing typical and advanced leafroll, but not all leafroll plants were from net-necrosis tubers.

"(4) Well marked symptoms of both mosaic and leafroll occurring simultaneously in the same plant have been observed in a number of instances."

Blodgett of New York has continued his "indexing" system of testing potatoes. (See mosaic).

The importance of the disease in 1921 is shown by the estimates of yield reduction given in Table 61.

Table 61. Estimated reduction in yield of potatoes caused by leafroll, 1921, according to collaborators.

State	Estimated percentage reduction in yield	State	Estimated percentage reduction in yield
Vermont	5-10	North Carolina	5
New York	1 or more	Indiana	3
New Jersey	5	Montana	2
Pennsylvania	10	Idaho	Slight
Maryland	2	Washington	t
Virginia	1	Oregon	t
Kentucky	10	California	6
Tennessee	t		

The following comments from collaborators are of interest in reviewing the situation of various states:

Vermont: On the average a little more than last year. Common everywhere, showing greatest injury in July at time of blossoming; 25% of the fields infested with perhaps 25% affected plants per field. (Lutman).

Becoming increasingly prevalent in Vermont. (Gilbert).

New Hampshire: More abundant than last year. (Butler).

Massachusetts: Common on home-grown stock. (Osmun).

Rhode Island: None observed. (Browning).

Connecticut: More or less seen, but apparently of the dry weather type. (Clinton).

New York: Extremely dry weather here made it hard to distinguish leafroll. "Blue sprouts" more heavily infested than white sprouts. (See Table 62 for results of inspections) (Chupp).

New Jersey: Slight trace on early crop, about 15% infection on the late crop. (Cook).

Pennsylvania: Very important. Reducing the yield in the state 10%. Field counts as high as 100% are frequent. (Thurston and Orton).

Kentucky: Leafroll was present in about the same percentage as last year and was a disease of considerable importance, occurring in 97% of the plantings with a percentage of 1 to 7%. I estimate the reduction in yield at 10%. (Valleau).

North Carolina: Common in the early Eastern Shore crop and also in the crop grown in the mountains. (Foster).

South Carolina: Unimportant. (Ludwig).

Mississippi: Not present to any extent in the state. (Neal).

Louisiana: Slight infection noticed in various parts of the state, but apparently of no economic importance as yet. (Edgerton).

Arkansas: Not observed. (Elliott).

Ohio: Our observation has been that with ordinary methods of handling a good stand of seed is badly run out by the third year. (Clayton).

Indiana: Serious feature in crop; not easy to detect. Of greenhouse tests, found in seed from nine counts, reducing yield 3%. (Gardner).

Michigan: Masked by hot weather effects. (Coons).

Wisconsin: A few cases of questionable identity. (Vaughan).

Minnesota: Probably the same as last year, not very important since very little was observed. Mostly obscured by hopper injury. (Department of Plant Pathology).

North Dakota: Not sufficiently pronounced to be specifically recognized. (Bolley).

South Dakota: Trace. (Evans).

Nebraska: Very slight. (Goss).

Kansas: No report. (Melchers).

Montana: Only occasional cases found in this state. (Jennison).

Colorado: Some leafroll reported in different sections, especially in the San Louis Valley. Extent of disease unknown. (Bureau of Crop Estimates report).

Utah: Leafroll is not clearly defined in Utah. (Richards).

Idaho: Fairly common; reducing yield slightly. (Hungerford).

Washington: Seen in two locations. (Dana).

Oregon: Prevalence unknown - no systematic survey. Probably more general than we have knowledge of. (Barss).

California: Very general throughout the state. All fields affected more or less. Losses ranging from 5-20% per field; in Los Angeles County, 30% injury. (Milbrath).

Table 62. Percentages of leafroll in potato fields inspected in New York during the summer of 1921.

County	No. of fields inspected	Acreage	Average percentage of leafroll	County	No. of fields inspected	Acreage	Average percentage of leafroll
Allegany	18	59.00	0.20	Niagara	4	6.75	1.14
Cayuga	17	54.50	0.42	Oneida	19	55.83	0.17
Chenango	5	12.75	1.76	Onondaga	22	83.33	1.13
Clinton	9	42.50	0.43	Ontario	15	64.16	Trace
Cortland	45	176.75	0.48	Orleans	7	45.00	2.02
Erie	28	62.00	0.55	Oswego	8	25.00	0.05
Essex	5	18.50	0.11	Seneca	9	39.75	0.17
Franklin	48	188.01	0.33	Steuben	10	53.50	0.46
Genesee	9	102.50	0.15	Washington	75	170.15	0.09
Livingston	7	37.50	0.92	Wayne	11	23.00	0.20
Madison	3	6.00	Trace	Wyoming	11	27.00	0.12
Monroe	41	186.30	0.55	Total	426	1539.78	0.43

Table 62 detailing results of field inspections is given to illustrate general field conditions in New York state. Although the figures are not high, leafroll being hard to detect, they throw light on the magnitude of the leafroll problem in northeastern United States, since these fields were for the most part grown from certified seed of 1920 and represent the conditions in standard certified lots of seed.

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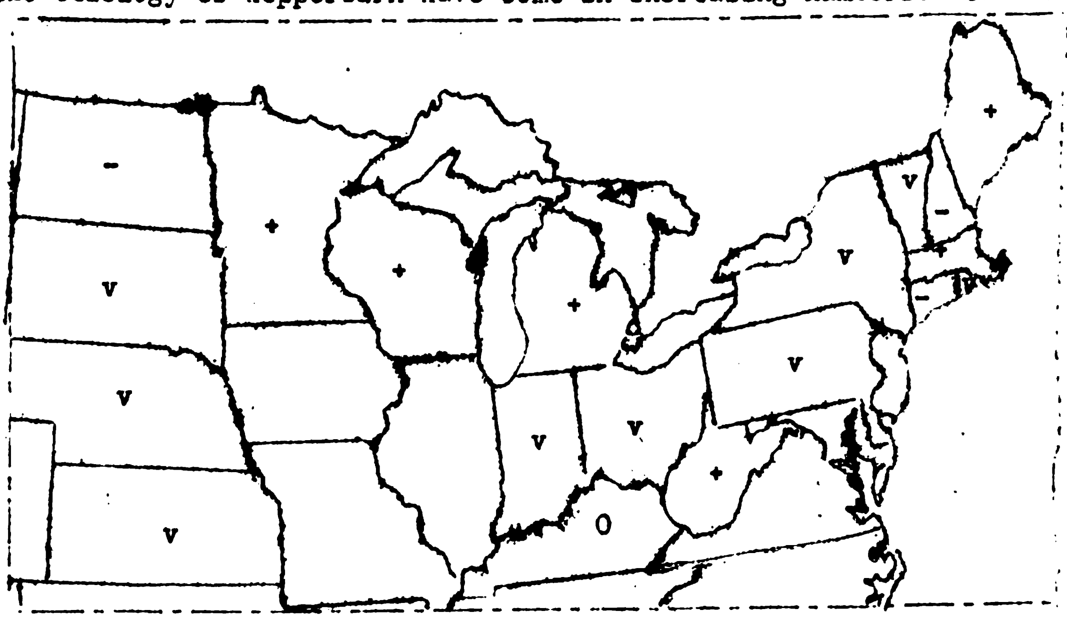
Tipburn (non-parasitic) and hopperburn induced by leafhoppers (Empoasca mali)

Tipburn and hopperburn were probably the most important troubles of potatoes last year and in the aggregate caused enormous money loss to growers. Entomological reports confirming the original work of Ball and his associates as to the etiology of hopperburn have come in increasing numbers. On the



\+ severe loss
v moderate loss
\- slight loss
o occurrence

Fig. 72. Importance of tipburn and hopperburn in 1921.

other hand, Lutman[5] maintains that there is a distinct trouble called tipburn associated with death of the marginal vein, due to loss of water and indicated by a browning of the entire region. The report from Bolley of North Dakota quoted below is interesting in this connection. Folsom and Schultz[3] confirm the position of Lutman, in stating that in Maine in 1921, the hopperburn type of tipburn was not seen. Comparative studies should be made and the facts ascertained for each state in order to determine the relative importance of these two troubles. In this discussion, no attempt is made to decide the type of tipburn the collaborator is reporting, but comment is freely quoted from the various states.

The importance of tipburn in 1921 is indicated in Table 63 and on the map (Fig. 72), and by the reports from collaborators quoted below.

Table 63. Losses from tipburn and hopperburn of potato, 1921.

State	Loss	State	Loss
Maine	Severe	North Carolina	2% severe hopperburn observed. (Shapovalov)
Vermont	5-10%		
New Hampshire	Prevalent	Mississippi	Trace
Massachusetts	Serious and general	Ohio	Widespread and severe
Rhode Island	Very common	Indiana	4%
Connecticut	Less than average year	Michigan	15-20%
New York	5-10%	Wisconsin	10% (moderate)
Pennsylvania	8%	Minnesota	10%
West Virginia	25%, worst trouble	North Dakota	Unimportant
Kentucky	Usually important	South Dakota	5%
Tennessee	Fairly destructive in East Tennessee	Nebraska	Considerable
		Kansas	Quite severe
		Montana	More common
		Idaho	Less important

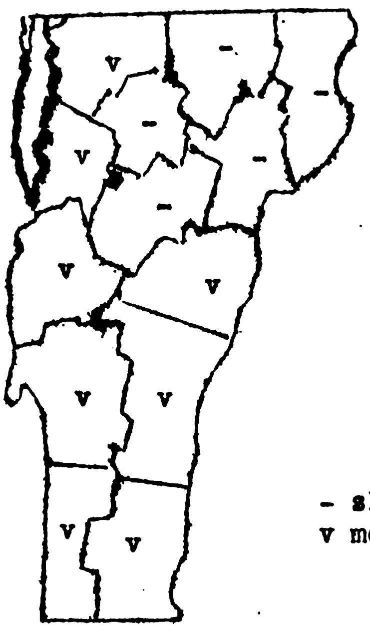


Fig. 73. Occurrence of tipburn in Vermont, 1921. (Lutman).

Quebec: Hopperburn occurs periodically whenever dry conditions prevail in potato growing areas. Has been very prevalent in Quebec (1921) and caused considerable loss. Irish Cobbler is more susceptible than Green Mountain. (B. T. Dickson[1]).

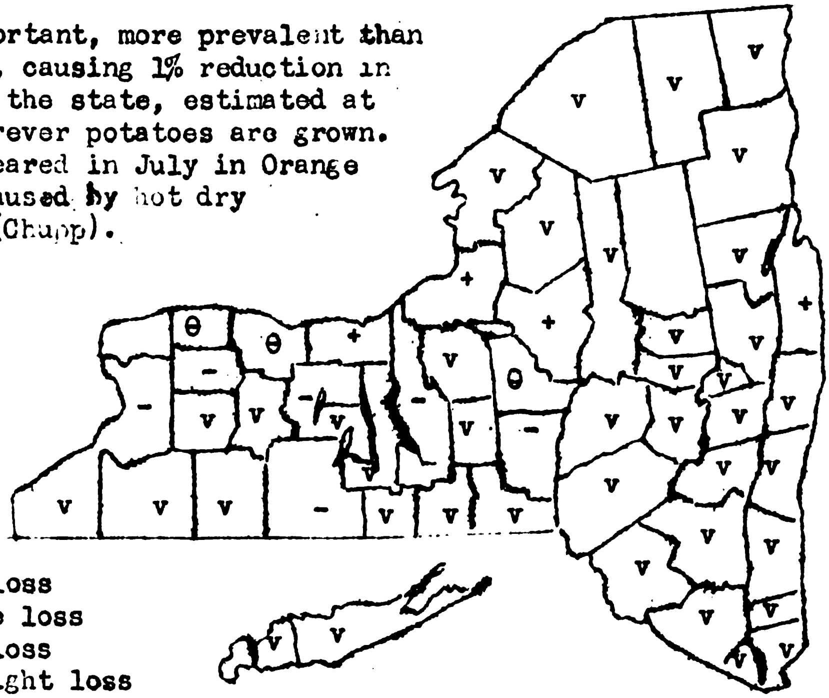
Vermont: Tipburn of physiological cause was much more prevalent in 1921, being the most important potato disease of the year and reducing the yield for the state 5-10%. The trouble was purely physiological, there being practically no hoppers. First seen July 6 at Burlington, doing greatest injury July 25. (Lutman).

Massachusetts: General on early

varieties in unsprayed fields. Green Mountain not seriously affected. Dibble's Russet practically not at all. (Osmun).

Connecticut: Next to prematuring, tipburn has been the most conspicuous potato trouble of the year. Due to quite variable weather rainy days followed by bright hot ones and unusual hot weather as a whole. (Clinton).

New York: Important, more prevalent than last year, causing 1% reduction in yield for the state, estimated at 5-10% wherever potatoes are grown. First appeared in July in Orange County, caused by hot dry weather. (Chupp).



\+ severe loss
v moderate loss
\- slight loss
θ very slight loss

Fig. 74. Tipburn and hopperburn of potatoes in New York, 1921. (Chupp).

Table 64. Percentages of tipburn in potato fields inspected in New York during the summer of 1921.

County	No. of fields inspected	Acreage	Average percentage of tipburn	County	No. of fields inspected	Acreage	Average percentage of tipburn
Allegany	18	59.00	5.00	Niagara	4	6.75	0.01
Cayuga	17	54.50	6.88	Oneida	19	55.83	20.64
Chenango	5	12.75	3.92	Onondaga	22	83.33	14.40
Clinton	9	42.50	6.59	Ontario	15	64.16	1.12
Cortland	45	176.75	9.60	Orleans	7	45.00	0.09
Erie	28	62.00	4.81	Oswego	8	25.00	50.00
Essex	5	18.50	5.14	Seneca	9	39.75	19.62
Franklin	48	188.01	10.89	Steuben	10	53.50	1.69
Genesee	9	102.50	1.96	Washington	75	170.15	18.72
Livingston	7	37.50	6.72	Wayne	11	23.00	26.30
Madison	3	6.00	0.01	Wyoming	11	27.00	16.00
Monroe	41	186.30	10.31		426	1539.78	10.57

Pennsylvania: More important than usual, causing 8% reduction in yield for the state, being very severe in the southeastern section on unsprayed fields, due to drouth. (Thurston and Orton).

Maryland: Trace. (Jehle and Temple).

West Virginia: More prevalent than usual, being the worst potato trouble in nearly all localities, causing a 25% reduction in yield for the state. Particularly severe in early varieties in the Ohio Valley and lower altitudes. A few localities in the higher altitudes not seriously affected. (Giddings).

Kentucky: This disease is usually important, but flea beetle injury was so severe this year that the injury from hopperburn could hardly be recognized. (Valleau).

Ohio: Tipburn is causing more damage at present than any other trouble. Between drouth and tipburn, the crops in central and southern Ohio have been practically a failure. In northern Ohio the early potatoes have suffered severely, but the trouble is not yet prevalent on the late crops. Leaf hoppers, which transmit this trouble, are very abundant in the fields of late potatoes. (Clayton).

Indiana: Less prevalent than usual, causing a 4% reduction in yield. A serious factor all over the state in the early crop, causing foliage reduction and premature death. The hot weather of June and July favored the disease. (Gardner).

Michigan: Experiments conducted at the Upper Peninsula Sub-station, Chatham, during the 1919 and 1920 seasons, as well as at other State experiment stations, have proved conclusively that the potato leaf hopper is the cause of the injury. The importance of the potato leaf hopper as a potato pest was demonstrated in a favorable season such as in 1919, when the potato vines in many sections of the state were killed as early as the latter part of July before the tubers had reached marketable size. As a consequence, a great many growers suffered an entire loss of the crop. The loss to the Upper Peninsula potato growers in 1919 from this injury alone was estimated at $1,000,000....... The overwintering adults and the nymphs of the first generation are of primary importance in the control of hopperburn for they give rise to the destructive second generation. The destruction of the adult potato leaf hopper is very difficult, but it can easily be repelled by applying some kind of covering to the potato vines which the leaf hopper does not like. Bordeaux mixture 5-5-50 serves this purpose very well and at the same time controls other diseases which attack the potato leaves. Bordeaux mixture should be applied from underneath so as to cover the under side of the leaves, as it is here that the adults lay their eggs and the nymphs feed. At least four applications should be made during the growing season. The first application should be made when the vines are from three to six inches tall, this to be followed about a week later by a

second spraying. The subsequent applications should be made at intervals of 10-14 days. The first two sprayings will repel the over-wintering adults, while the later sprayings will ward off the adults of the first generation which come to potato fields to lay egg for the second generation. (Kotila4).

Fifteen to twenty percent loss. (Coons).

Wisconsin: More prevalent than usual, being most severe in the central and southern parts of the state, causing a 10% reduction in yield. First appeared June 25 at Madison, doing greatest injury during the hot, dry period from July 1 to August 25. Triumph and Ohio were highly susceptible. Green Mountain medium, and Rural New Yorker resistant. (Vaughan).

Minnesota: Very important, most serious disease of potato, being much more prevalent than usual, and causing a 10% reduction in yield for the state. (Section of Plant Pathology).

Iowa: Fifteen percent reduction in yield. (Melhus).

North Dakota: Tipburn rather common. In association with heat during late June and early July, appeared to result in a good deal of destruction. Do not think there is any indication that this disease is particularly associated with the attack of leaf hoppers. No doubt these insects increase the destruction. It seems to be wholly associated with some root trouble which causes the plants to fail to furnish sufficient water to meet the transpiration taking place on the marginal points of the leaf and particularly from the water pores. It is naturally pronounced in its destruction at times when transpiration is excessive and moisture is deficient. (Bolley).

South Dakota: Very important, causing a 5% reduction in yield for the state. Scarcely a field is without it. (Evans).

Montana: More commonly seen than last year, especially during the latter part of the summer when weather was hot and dry. (Jennison).

Fenton and Ressler[2] have produced a tipburn artificially with injections of emulsions made from adult leaf hoppers. They suggest that Bordeaux mixture does not prevent tipburn by its action on the leaf, but rather by its action on the insect.

Recent literature

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1. Dickson, B. T. Diseases of potato. Sci. Agr. 2: 55-57. Oct. 1921.
2. Fenton, F. A. and I. L. Ressler. Artificial production of tipburn. Sci. n. s. 55: 54. Jan. 13, 1922.
3. Folsom, Donald and E. S. Schultz. Potato tipburn in northeastern Maine. (Abstract) Phytopath. 12: 36. 1922.
4. Kotila, J. E. Quart. Bul. Mich. Agr. Exp. Sta. 3: 128-131. May 1921.

5. Lutman, B. F. Pl. Dis. Bul. 5: 52. Aug. 1, 1921.

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Eyer, J. R. The influence of leafhopper control on potato yields. Jour. Econ. Entom. 14: 69-71. 1921.
(Abstract by A. B. Massey in Bot. Absts. 9: Entry 1558. 1921.)

Fenton, F. A. Progress report on the season's work on the production of potato tipburn. Jour. Econ. Entom. 14: 71-83. 1921.
(Abstract by J. E. Kotila in Bot. Absts. 9: Entry 1560. 1921.)

Anthracnose caused by Colletotrichum atramentarium (Berk & Br.) Taub.

Anthracnose was reported from two states this year - Ohio and West Virginia. It was less prevalent than last year in Ohio where it was first found October 21 in Geauga County, and was of slight importance. For West Virginia, Giddings, on August 29, reported anthracnose causing quite a little injury in one field near Morgantown. He says, "There is no doubt in my mind from all the evidence secured in the laboratory as well as in the field that the Colletotrichum was the cause of the injury in this case. I cultured the fungus from lesions on the live stalk and secured practically pure cultures in every case."

Tuber rots caused by Fusarium spp.

This type of trouble, showing chiefly as a rot of the stored product, is, in the aggregate, as shown by the market inspection reports (Table 65) a source of enormous loss. Reports in general need to be interpreted in the light of conditions at time of shipment, and with reference to the part of the country from which shipments arise. In general it may be said that western grown potatoes, due perhaps to sweating in cars and to particular pathogens, are seriously injured during their long transit, while eastern grown stock is prone to rot in shipment or storage only if the tubers are bruised or wounded or if ventilation is neglected. The figures for the Michigan 1920 crop are complicated by the existence of much injury from "field frost" which passed rapidly into Fusarium decay or into slimy soft rot. (Contrast 1920 figures for Michigan with 1921 figures.) In the main, the figures but serve to show the existence of problems peculiar to sections, and of problems in crop handling and transportation deserving of continued work.

Table 65. Losses from Fusarium tuber rot caused by Fusarium spp., as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	Range of dates of inspection	Number of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
		1920 CROP			
Colorado	Jan. 6-April 13	16	4	4	6-13
				12	2-4

Origin of shipment	Range of dates of inspection	Number of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
Delaware	April 9 - May 14	2	2	2	2
Idaho	Mar. 7 - April 30	3	3	3	2-4
Illinois	Febr. 24-28	3	3	3	1-6
Kansas	Mar. 14	1	5	1	5
Maine	Jan. 5 - July 21	65	6	3	27-47
				13	5-20
				49	2-4
Maryland	Mar. 17-21	2	4	2	2-6
Michigan	Jan. 4 - July 21	129	3	2	25-30*
				13	5-17*
				114	1-4
Minnesota	Jan. 3 - June 3	130	4	31	5-15
				99	1-4
Montana	Mar. 28 - May 24	5	3	5	2-5
Nebraska	Jan. 10 - Mar. 17	11	10	7	5-20
				4	2-4
New Jersey	Jan. 4 - Mar. 16	2	4	2	3-5
New York	Jan. 6 - July 6	114	4	32	5-20
				82	1-4
North Dakota	Jan. 3 - Mar. 26	10	4	3	5-10
				7	2-4
Oregon	Mar. 2 - April 21	2	4	2	3-5
Pennsylvania	Mar. 11 - May 2	9	7	7	5-14
				2	2-4
Washington	April 29	1	15	1	15
Wisconsin	Jan. 5 - June 13	55	3	7	5-12
				48	1-4
Wyoming	Febr. 1	1	4	1	4
Canada	Febr. 3 - June 2	21	3	21	1-6
Unknown	Jan. 4 - June 22	63	4	1	35
				6	6-13
				56	1-4
Total		645			
		1921 CROP			
Alabama	June 10	1	9	1	9
California	July 22 - Nov. 11	7	2	7	2#
Colorado	Aug. 22 - Dec. 1	28	9	4	27-35#
				8	5-18
				16	2-4
Delaware	Aug. 4-29	8	9	3	10-33
				6	3
Florida	Apr. 5 - May 9	11	4	4	5-7
				7	2-3
Georgia	June 6 - July 13	4	3	4	2-5
Idaho	Aug. 24 - Dec. 7	13	6	1	35
				3	7-8
				9	2-4
Indiana	Sept. 3	1	2	1	2

Origin of shipment	Range of dates of inspection	Number of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
Kentucky	July 12	1	27	1	27
Louisiana	May 17 - Oct. 7	21	5	1	40*
				2	5-10
				18	2-4
Maine	July 21 - Dec. 2	51	4	11	5-22
				40	2-4
Maryland	July 5 - Aug. 10	26	4	5	6-13
				21	1-4
Massachusetts	Aug. 18	1	12	1	12
Michigan	Sept. 23 - Dec.13	21	2	21	1-5
Minnesota	Aug. 27 - Dec. 13	55	5	1	65
				12	5-23
				42	1-4
Montana	Sept. 26 - Dec. 7	23	4	5	5-10
				18	1-4
Nebraska	July 25 - Nov.22	14	14	2	55-65
				2	20-25
				10	2-5
New Jersey	July 18 - Dec. 8	123	7	24	12-35*
				33	5-10
				66	1-4
New York	Aug. 20 - Dec. 8	51	2	3	5-10
				48	1-4
North Carolina	June 11 - July 19	33	10	5	30-43*
				10	5-18
				18	1-4
North Dakota	Nov. 19 - Dec. 9	4	3	4	2-4
Ohio	Oct. 10	1	4	1	4
Oklahoma	July 14	1	83	1	83*
Pennsylvania	Aug. 17 - Nov. 21	2	4	2	4
South Carolina	May 27 - June 3	17	6	5	8-27
				12	1-4
South Dakota	Nov. 1	1	2	1	2
Texas	May 10	1	6	1	6
Utah	Aug. 17 - Oct. 27	7	4	7	2-8
Virginia	Apr. 29 - Aug.22	170	7	4	55-85*
				13	15-45
				42	5-13
				111	1-4
Washington	Dec. 8	1	6	1	6
Wisconsin	Oct. 20 - Dec. 15	6	3	6	2-5
Canada	Oct. 31 - Nov. 26	4	2	4	2-3
Unknown	July 7 - Dec. 13	52	7	2	55-65
				3	25-27
				10	5-10
				37	1-4
Total		760			

Total number cars of potatoes inspected (calendar year 1921) 6,035

* Associated with slimy soft rot. # Associated with leak.

Recent literature

Goss, R. W. Temperature and humidity studies of some Fusaria rots of the Irish potato. Jour. Agr. Res. 22: 65-79. Pl. 10-11. Oct. 8, 1921.

Jelly end rot, probably caused by *Fusarium* sp.

Western States: Jelly rot is a persistant and very annoying trouble in the irrigated sections, associated with the long-shape varieties, such as Burbank and Netted Gem. As the writer has pointed out on several other occasions, this trouble presents a great deal more complicated condition than if it were merely Fusarium stem-end rot. Moreover, certain preliminary cultural work of the last two seasons tends to indicate that the true jelly decay may not at all be due to Fusarium. How and why this trouble came about and how it may be prevented - for these questions we have no answer at present. (Shapovalov).

Idaho: Unimportant, occurring in isolated cases. (Raeder).
Jelly end rot is affecting the Gems rather more than in southern Idaho owing to the fact that there is a large percentage of stock that is very much pointed at the stem end. Of course, this difficulty or disease only affects the off-shape tubers. (E. R. Bennett, Boise).

Washington: Occurred in Yakima County. (Dana).

Leak caused by *Pythium debaryanum* Hesse or *Rhizopus nigricans* Ehr.

The following summary of the market situation with reference to leak by G. K. K. Link[1] is important:

"Field and market observations made during the past few years seem to indicate that leak is virtually coextensive with the potato crop of the United States, and that it is a serious transit and storage disease. In the terminal markets it has been noted in potatoes from New Jersey, New York, North Carolina, Louisiana, California, Washington, Idaho, Montana, Wyoming, Colorado, Nebraska, and Minnesota. The heaviest losses have been observed in Rurals shipped out of Idaho during the hot weather of August and September. The disease seems to occur in potatoes from other sections if the crop is dug and moved during warm weather. Potato men are reluctant to store early potatoes because 'they do not keep'. One of the reasons for this situation is the manace of leak in both early and late potatoes if dug and stored during warm weather. During September and October of 1921, the losses in Rurals and Burbanks in Idaho storage houses were heavy. It has been demonstrated by isolations and inoculations that most cases of leak are caused by Pythium-like fungi. During the four years only four cases of leak due to *Rhizopus* spp. and two due to *Mucor* spp. were found. Leak has been produced experimentally with the Rhizopus species, but not with the species of Mucor."

Other collaborators report as follows:

Ohio: Leak (Rhizopus nigricans), one report only, October 11, in Cuyahoga County, as a storage rot. (Detmers).

Idaho: Important in mid-season potatoes. (Hungerford).
I have found one or two cases since digging time of what I pronounced as leak, although I did not make cultures. (Bennett).

Washington: Two reports feo 1921. (Dana).

Literature cited

1. Link, Geo. K. K. Leak, a serious transit disease of potatoes. (Abstract) Phytopath. 12: 38. Jan. 1922.

Germination troubles due to various factors

Germination trouble was reported from a number of states including Maine, Virginia, North and South Carolina, Texas, Ohio, Indiana, Michigan, Wisconsin, and Colorado. The poor condition of seed potatoes in storage and especially the weather at planting time are responsible for the severe losses reported. The trouble was complicated by attack on seed pieces by the seed corn maggot (Pegomyia fuscipes) in some states, but in general it was due either to mere failure to germinate or to rotting of the seed pieces by Fusarium. Probably in the southern Coastal states the extremely hot weather of March was very significant in leading to excessive rotting.

In addition to the reports previously published (Pl. Dis. Bul. 5: 17-18, 53. July 1 and August 1, 1921), the following comments from collaborators give the facts for the various areas:

Maine: The extreme southern part of Aroostook County, and the rest of the state on an average in a worse degree, has been badly hit by the drouth. A part of this effect showed itself in misses and failure to germinate. I have seen numerous cases in southern and central Maine where the stands are very poor. (Morse).

Virginia: Combination of high air temperature and low soil moisture producing unusually high soil temperatures during planting season. (Fromme).
The condition of many potato fields in the Norfolk and Eastern Shore sections is very serious and discouraging. While there are some perfect fields or portions of fields (for instance in central and northern sections of Northampton County), 15% of missing hills is very common, even 25 to 30% of loss is frequent and in a certain number of cases it reaches 50 to 60%, being in exceptional cases as high as 75%. Fields showing from 50 to 75% of damage are regarded as unprofitable and are being plowed and planted over again. (Shapovalov).

North Carolina: (May 24) For the past two weeks I have divided my time between several of the mountain counties and those along the

eastern coast. It is a little too early to see much in the mountain section as the potatoes are just coming out of the soil. They have not had the potato germination trouble, however, and in all sections the stand is practically perfect. The weather has been very unfavorable to crops in eastern Carolina. The rains accompanied by cool days and nights have necessitated the replanting of cotton, corn, and melons several times with distressing results so far. A lot of the potatoes are rotting in the soil, some of it being caused by the blackleg organism, some by the constant dampness of the soil, and possibly some by the prevalence of a number of the physiological diseases, such as mosaic and leaf curl, which caused weakened plants. (Foster).

<u>South Carolina:</u> Germination troubles were more prevalent and more important than usual this year, especially in the lower part of the state where growers failed to obtain stands. The trouble was first noticed at Ladson on March 9, and was probably caused by the hot dry season. (Ludwig).

<u>Indiana:</u> Extreme heat the latter part of June caused germination trouble to be much worse than usual in the late crop in central Indiana. In 50% of the fields 25% of the plants were affected, causing a 20% reduction in yield, some growers suffering almost total loss. Excessive rains, as well as extreme heat, may have had some effect. (Gardner).

<u>Michigan:</u> Poor stand, especially in northern half of Lower Peninsula. Potatoes commonly replanted because of failure. Whole fields commonly replanted because of failure. Whole potatoes used for seed showed marked superiority. In large part, trouble due to hot soil conditions, but poor storage conditions had weakened many tubers. (Coons).

<u>Colorado:</u> Around Greeley there is considerable variation in the condition of things. The late planted potatoes look very poor. The trouble is due solely to the rotting of the seed piece, as I have described many times. (MacMillan).

Quotations from special reports by Fromme and by Shapovalov concerning the Virginia conditions are to be found in the Plant Disease Bulletin 5: 17-18. 1921. Shapovalov isolated <u>Fusarium oxysporum</u>, <u>F. coeruleum</u>, and <u>F. radicicola</u> from decaying seed pieces. The following statement regarding the temperature relations of these three fungi, is taken from Shapovalov's report:

"It is interesting to note that <u>F. radicicola</u> and <u>F. oxysporum</u> thrive best at high temperatures, while <u>F. coeruleum</u> gives best growth at moderate temperature. It shows, therefore, that different contributing environmental factors mentioned in the report varied in their importance in various localities. It is probable that in the case of <u>F. oxysporum</u> and <u>F. radicicola</u> the high temperature which prevailed during the first part of March was of prime importance in bringing about the decay, while in the case of <u>F. coeruleum</u> very

likely winter storage of seed potatoes facilitated the development of incipient stages of rot which progressed to alarming proportions after planting."

New or little known diseases

Leaf hopper injury (not hopperburn) was reported by J. G. Leach[2] from Minnesota as follows:

"During the summer of 1921 a hitherto undescribed pathological condition of the potato plant was observed in Minnesota. Affected plants were characterized by a pronounced shortening of the leaf petioles, with the consequent crowding of the leaflets. The petioles and mid-veins of the leaflets also were much shorter than normal and the tips curved sharply downward and backward towards the petiole. At the same time, the margins of the leaflets were folded upward along the mid-vein. The potato leaf hopper (*Empoasca mali*) was very abundant and was constantly associated with the disease. By placing a number of the insects collected from affected plants on normal, healthy plants grown under cages, it was proved experimentally that the leaf hoppers were responsible for the disease. All plants so treated developed typical symptoms within seven days, while all check plants remained normal. Sufficient data have not been obtained to justify conclusions as to the nature of the disease and its relation to hopperburn cuased by the same insect. The condition was very prevalent in Minnesota in 1921 and was undoubtedly responsible for considerable reduction in yield."

"Bliss Triumph, Green Mountain, Irish Cobbler, and Early Ohio are susceptible in the order mentioned." (Supplemental report from Leach).

Yellow dwarf (cause undetermined) was reported from New York by Barrus and Chupp as follows:

"A hitherto undescribed disease of potatoes, called 'Yellow dwarf' because of its effect on the vines, has been observed in New York State.

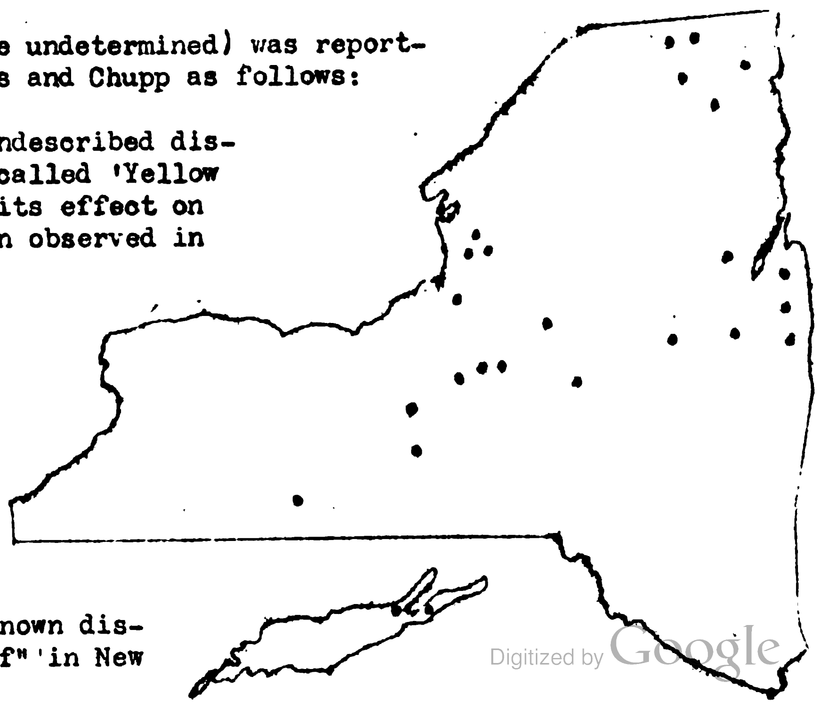


Fig. 75. Present known distribution of "yellow dwarf" in New York, according to Chupp.

Not only are affected plants dwarfed and the foliage yellowed, but there is a necrosis of the pith and cortical cells in the vicinity of the upper nodes of the stalk. Death of affected stalks takes place from the top downward, beginning with terminal and upper axillary shoots. Tubers from affected plants are usually small, irregular, more or less sessile, brittle, and often badly cracked. There is considerable internal discoloration in the form of rusty brown specks throughout the outer medullary tissue, often extending to the bud end but rarely to the stem end of the tuber. The number of discolored areas increases with the age of the tuber. A dry rot from the stem end, which finally involves the entire tuber, occurs on badly affected tubers. Even those otherwise apparently healthy can be detected by the more prominent lenticels. The disease affects at least eighteen varieties of potatoes and no variety has been found resistant. The agency causing the disease has not been determined. Infection evidently takes place from the soil and from infected tubers capable of producing plants."

Russet dwarf (cause unknown) was less prevalent in Idaho than in previous years. In this disease the plants are stunted; lower leaves turn brown and drop; vascular portion of stems and leaves turn brown; general russetting of leaves or entire plant late in season occurs. (Hungerford). Percentage of infection varied from a trace to 35%. (Raeder).

Chlorosis (non-parasitic) was reported from Colorado, Idaho, and Washington. Idaho (Hungerford) - Chlorotic condition reduces yield somewhat in irrigated fields in southern Idaho. Colorado (Shapovalov) - Calico was quite omnipresent. Washington (Dana) - Three reports.

Literature cited

1. Barrus, M. F. and Charles Chupp. Yellow dwarf of potatoes. (Abstract) Phytopath. 12: 39. Jan. 1922.
2. Leach, J. G. Leaf hopper injury of potatoes. (Abstract) Phytopath. 12: 37. Jan. 1922.

Other diseases

Leaf blotch caused by Cercospora concors (Casp.) Sacc., typically a disease of cool moist areas, was reported only from West Virginia (Giddings). The disease was quite prevalent in a few gardens and was evidently the cause of considerable injury. The badly affected leaves dropped off very easily and there were very few leaves left near the tops of the plants.

Black heart (non parasitic). The general loss from black heart seemed far less in 1921 than in 1920. No cars containing it being called to the attention of market inspectors from January 1, 1921 to July 1, 1921. No doubt this can be attributed to better shipping practices and the mild winter. On the other hand, the mild winter lead to poor keeping quality in the stored product and seed planted in 1921 was in general of low vitality. This factor, along with weather and soil conditions served to give the extremely poor stands in many states.

The following comments are of interest:

New York: Observed in poor storage houses and where potatoes are shipped in car with stove. (Chupp).

Michigan: Important losses in storage due to poor ventilation in pits and warehouse bins. Poor stand in part due to seed of low vitality. (Coons).

North Dakota: Unimportant. (Couey).

Washington: Five cases. (Dana).

Heat necrosis of unknown cause was reported from California (Milbrath) from spring crop fields in southern California. The loss for the state was given as .5%, but as much as 60% was observed in one field.

DISEASES OF TOMATO

Leaf spot caused by Septoria lycopersici Speg.

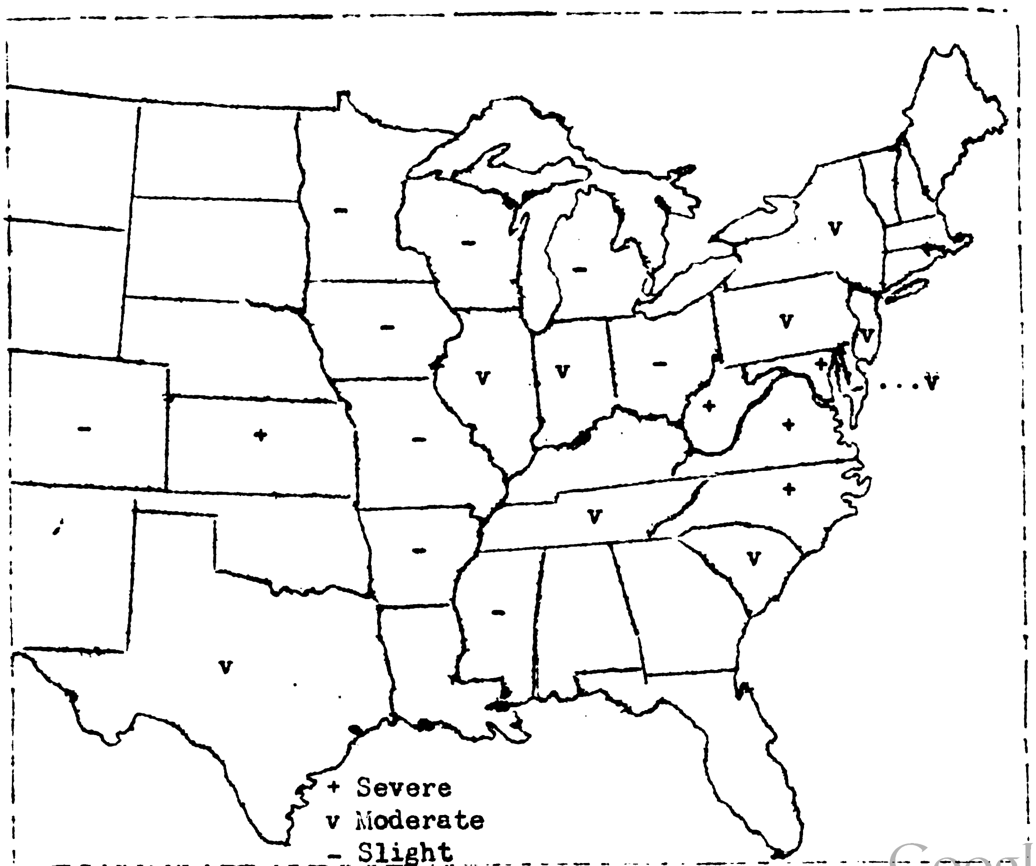


Fig. 76. Importance of Septoria leaf spot of tomato, 1921.

The Survey records contain reports of this disease from every state in the Union except Oregon, Montana, Idaho, Wyoming, Nevada, Utah, Arizona, and New Mexico. The disease was reported from practically the entire range last year and was said to be severe in Maryland, Virginia, West Virginia, North Carolina, and Kansas.

Table 66. Estimated percentages loss from tomato leaf spot, 1921

State	Percent loss	State	Percent loss
New York	3	North Carolina	10
Pennsylvania	1-2	Texas	3
Maryland	25	Indiana	5
Virginia	30*	Iowa	2
West Virginia	25	Kansas	10

*General and severe as usual.

The following comments are of interest. (For others see Pl. Dis. Bul. 5: 81, 116. Sept. 1 and Oct. 1, 1921.)

United States (General): Septoria lycopersici frequently kills the blossoms but I doubt that it causes much if any shedding of the fruit. (F. J. Pritchard).

Pennsylvania: Serious stem injury at about the time of fruit maturity. (Orton and Thurston).

New Jersey: The Septoria lycopersici leaf blight caused much injury to early and so-called second early tomatoes in New Jersey during 1921. Infection was irregular in many localities. In some fields the plants were defoliated before the fruit matured, causing premature ripening and shedding of fruit. A tomato field was examined near Haddonfield on July 28, - at this time there was no Septoria leaf blight found. By August 16, the leaves of the same plants were 100% infected by this fungus, and a large percentage of the leaves had fallen. Satisfactory progress was made in controlling the disease with wet Bordeaux sprays, and dust treatment. (R. F. Poole).

Delaware: Serious locally where rainfall has been heavy. (Adams).

West Virginia: More prevalent than usual or than last year; affected every plant in every field in the state; loss 25%. Caused destruction of leaves and stem injury. General, but most severe in lower altitudes of central and eastern sections. Worst during August, when fruit was ripening. Less moisture than usual, unusually hot. Bordeaux 5-5-50 with rosin fish oil soap gave good control and increased yield, amounting to from 50 to 200% in demonstration patches. (Giddings).

Indiana: Spraying not practiced; defoliation and consequent sunscald caused the greatest loss. (Gardner).

Dates of first appearance of tomato leaf spot, 1921

May 21... Wood County, W. Va.	July 10.... New Jersey
May 29... Tompkins, N. Y. (Probably carried from greenhouse or seed)	July 23.... Harrison County, Ohio.
June 1... Lake County, Ind.	August 10.. Delaware
June 14.. Hazelhurst, Miss.	August 23.. Windsor, Conn.
	August..... Fort Collins, Colo.

Weather relations

The leaf spot disease is known in general to be favored by wet seasons. The relation of rains to spore dissemination is obvious. Comparison of the rainfall maps for July and August shows some coincidence of areas of most severe loss and those of heaviest rainfall, but in each case the facts must be viewed with regard to the type of crop grown - whether early or late canners is concerned, etc. The agreement in reports from Wisconsin, Michigan, and Minnesota as to its lessened importance during 1921 presents also confirmatory evidence of the close relationship between the development of this disease and weather conditions, but close study in a limited region will probably be necessary to determine definite correlations.

Control of Septoria leaf spot

The following statement by F. J. Pritchard of the Office of Cotton, Truck, and Forage Crop Disease Investigations, summarizes American conditions with regard to the control of this disease:

> "Spraying tomatoes is practiced to some extent, but not generally. The cost of the spray outfit, the uncertainty of the results because of the impossibility of spraying during prolonged periods of wet weather, and the large amount of labor and team work involved when men and teams are most needed are the chief causes of so little spraying.
>
> "Very little dusting of tomatoes has been done, as dusts have not, as a rule, seemed to be so effective as sprays. However, the use of dusts needs further investigation, for, if effective dusting can be done it will appeal to the grower much more strongly than spraying. Considerable areas can be dusted with a relatively cheap outfit and with relatively little labor and team work as compared to spraying."

Recent literature

Pritchard, F. J. and W. B. Clark. Effect of copper soap and Bordeaux soap spray mixture on control of tomato leaf spot. Phytopath. 9: 554-564. 1919.

Pritchard, F. J. and W. S. Porte. Use of copper soap dust as a fungicide. Phytopath. 11: 229-235. 1921.

____________ Relation of horse nettle (Solanum carolinense) to leaf spot of tomato (Septoria lycopersici). Jour. Agr. Res. 21: 501-505. Pl. 95-99. 1921.

____________ Effect of fertilizers and lime on control of tomato leaf spot (Septoria lycopersici). Phytopath. 11: 433-445. Nov. 1921 (Feb. 1922).

Smith, L. B. and H. H. Zimmerley. Relation of pressure to effectiveness in spraying tomatoes. Virginia (Norfolk) Truck Exp. Sta. Bul. 33/34: 163-190. 1921.

Fusarium wilt caused by Fusarium lycopersici Sacc.

This disease which is most common and most serious in the southern part of the country, has occasionally been reported to the Plant Disease Survey from states as far north as New Hampshire, Massachusetts, Michigan, and Iowa. Somewhere along the line from southern New Hampshire westward is the "tension zone" for this species. With the extremely early seasons of the past year and the high soil temperature prevailing - the latter factor being conceived to be the chief determinant in the occurrence of this disease - it was to be expected that the northern range would be extended, and also that the disease would be more severe than usual during 1921. The following comments from collaborators are important in this connection (For other reports, see Pl. Dis. Bul. 5: 54, 81, 116-117. 1921).

New Jersey: The Fusarium wilt of tomatoes is not widely distributed in New Jersey. It is severe in localities in Gloucester, Burlington, and Camden Counties. There was a 65% loss of large plants of the Stone variety in one two-acre field in Camden County. The infected areas appear to be isolated in both localities and fields where the disease was observed. (R. F. Poole).

Georgia: Wilt was very serious. (McClintock).

Arkansas: Fusarium wilt of tomato was unusually severe even in supposedly resistant varieties. (Elliott).

Ohio: The long,hot, dry period has especially favored the development of the fungus responsible for the wilt disease of tomato; losses were serious in both early and late varieties. (Thomas).

Indiana: Hot early summer (May, June, and July) increased the severity of tomato Fusarium wilt. (Gardner).

Michigan: Present in considerable amount in a field in southeastern Michigan. (Coons).

Iowa: More than last year or the average year. Serious in isolated localities. (Melhus).

Kansas: More than last year. The loss caused by this disease has been increasing from a trace up to 5% now. As much as 100% infection in some fields. This disease is becoming worse and more widespread. (Melchers).

Montana: Fusarium wilt of tomatoes found. (Jennison).

Table 67. Estimated losses from Fusarium lycopersici on tomato, as reported by collaborators, 1921.

State	Percent loss	State	Percent loss
Pennsylvania	1-2	Louisiana	25
Maryland	5	Texas	5
Virginia	30	Arkansas	10
Kentucky	33	Ohio	15
North Carolina	6	Indiana	3
South Carolina	3	Kansas	5

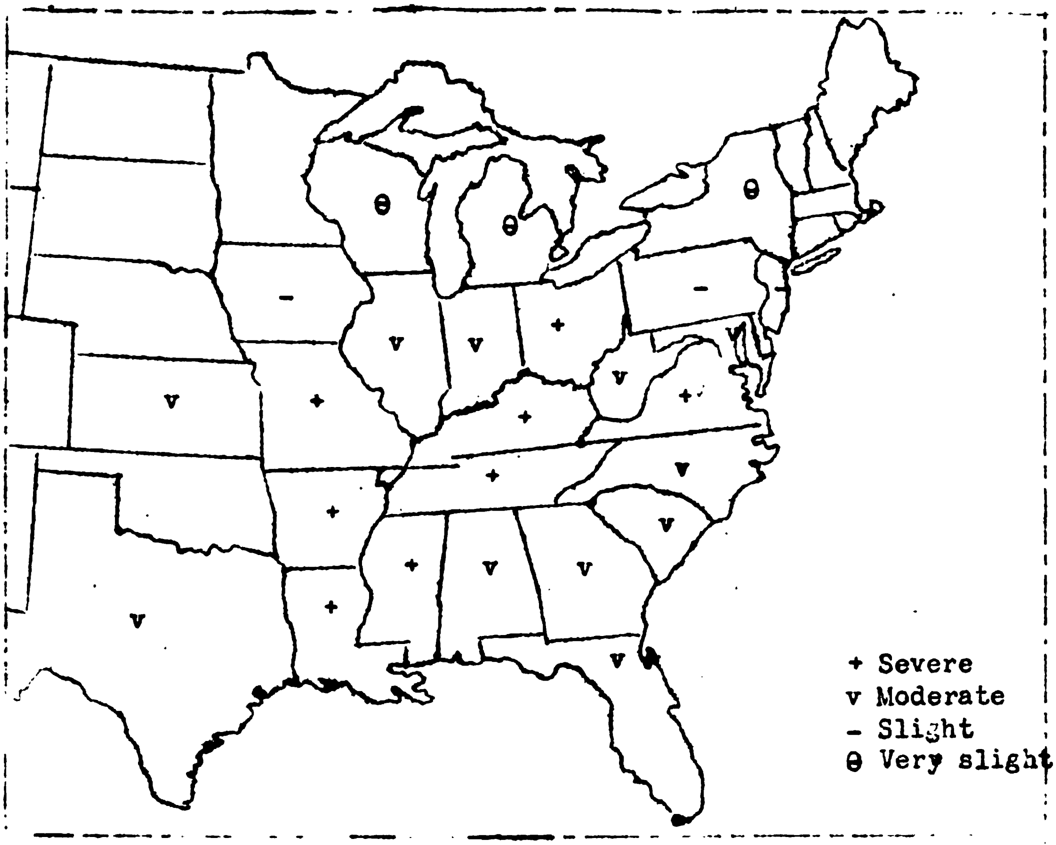


Fig. 77. Distribution and importance of Fusarium wilt of tomato, 1921.

Dates of first appearance of wilt, 1921.

May 21... Wood County, W. Va.
May 25... Utica, Miss.
June..... Wayne County, Ohio.
June 27... Clemson College, S. C.
July 15... Newark, Del.

Observations by Gardner show the importance of southern grown seedlings in introducing the wilt organism. Every spring thousands of seedlings are shipped north and soil infestation with the root knot nematode and with fungous diseases results.

Indiana: In the canning crop wilt was confined largely to southern grown plants imported from Georgia and Louisiana. Caused strong sentiment among growers against the use of southern growm tomato plants. Out of 76 fields surveyed, 43 (or 56%) showed the presence of wilt, 35 fields of these contained southern grown plants, of which 29 showed wilt, or 83% of the fields containing southern grown plants showed wilt. In fields containing both home-grown and southern grown plants the wilt was usually present only in southern grown plants. (Gardner).

Control of Fusarium wilt

The following general statement concerning the increasing use of wilt-resistant tomato varieties is by F. J. Pritchard:

"Wilt-resistant tomatoes are being used more and more commonly in wilt-infected areas. They have enabled the grower of home gardens heavily infested by wilt to produce an excellent crop of fruit when they obtained little, and in many cases no fruit, with ordinary commercial varieties. They are gradually invading the areas of commercial canners and are even used to some extent by canners that are not in wilt-infested areas because of their excellent yield and quality of fruit. As soon as the new early varieties now being developed for early trucking are distributed, growers for the early market will also be able to use them. Their more extensive use is also made possible by several seedsmen who have listed them in their catalogs."

The following reports on the use of resistant varieties have been obtained from collaborators:

Maryland: Losses are decreasing on account of use of wilt-resistant varieties. (Jehle and Temple).

Kentucky: A strain of Resistant Stone was tolerant, 75% harvested. Greater Baltimore, resistant strain was not resistant. Pink Beauty was not resistant; Essary was fairly resistant, but not the type for market. (Valleau).

Georgia: Tests conducted in Georgia during the past three years indicate that strains developed in one section of the state are not equally adaptable to all parts of the state. (McClintock[1]).

Mississippi: Large quantities of wilt-resistant seed were again distributed. (Neal).

Louisiana: Wilt-resistant selections have been giving excellent results. Probably about 5% of the tomatoes planted last year were of the resistant varieties. The percentage will be larger this year. (Edgerton).

Ohio: Results for the past season have been encouraging. (Selby).

Recent literature

Cited

1. McClintock, J. A. Tomato wilt. Georgia Agr. Exp. Sta. Bul. 138: 40. 1920.

Not cited

Edgerton, C. W. and C. C. Moreland. Tests of the wilt resistance of different tomato varieties, Louisiana Agr. Exp. Sta. Bul. 184: 1-24. Nov. 1921.

Pritchard, F. J. Development of wilt-resistant tomatoes. U. S. Dept. Agr. Bul. 1015: 1-18. Pl. I-X. Mar. 1922.

Western yellow blight attributed to Rhizoctonia spp. and Fusarium spp.

This disease was reported from Idaho, Washington, Oregon, and California as more severe even than in 1920 when more than 10% of the crop was reported lost. It seems to have been the limiting factor in tomato production in these states. Probably no disease of the crop in the west needs closer attention in order to clear up confusion as to etiology. A promising report of the marked resistance of certain varieties comes from Idaho. The following comments of collaborators show the general situation:

Idaho: Scattered in southern end of state. In kitchen gardens as well as commercial fields. Infection varies from trace to 5%. Also common in North Idaho. Marked resistance shown by some varieties and selections which are being tested by the Idaho Station. Disease more severe this year than last. (Hungerford).

Washington: This disease is appearing with its usual severity in various parts of the state. (Dana).

Oregon: Causing close to 50% loss in the region of The Dalles which is the main tomato growing area of the state. It is the one chief limiting factor to the successful production of tomatoes in that region. (McKay).

California: More severe this year than during the previous four years. Controlling factor in summer crop. About 15% is the average for the state. The range of loss extended from 2 to 100% for the fields of southern California and from 2 to 15% for central California. (Milbrath).

Table 68. Estimated percentage loss from yellow blight of tomato, 1921.

State	Percent loss	Date of greatest damage	Earliest report
Idaho	20	August	July
Washington	10	-	August
Oregon	3	August	-
California	15	July 15 - August 15	June 1

Early blight and nailhead spot caused by __Macrosporium__ spp.

Early blight as a diseased condition considered apart from the fruit disease, nailhead spot, was reported for the most part from the northern area, where it caused serious damage in only four states. While nailhead fruit spot was reported by collaborators from Florida and Louisiana only, it was found on tomatoes shipped from California, Mississippi, and Texas, according to the reports of inspectors of the Bureau of Markets and Crop Estimates, which are summarized in Table 69. In most of the reports from the southern states where nailhead spot occurs, no differentiation was made between early blight and nailhead spot.

Table 69. Losses from nailhead spot of tomatoes as shown by examination of cars at destination by food-products inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	Number of cars with nailhead spot	Average percentage of nailhead spot	Range of percentage of nailhead spot: Number cars	Range of percentage of nailhead spot: Percent
California	1	15	1	15
Florida	38	16	1	100
			7	25-50
			24	5-20
			6	2-4
Mississippi	2	5	2	4-6
Texas	1	11	1	11
Mexico	1	6	1	6
West Indies	1	10	1	10

Number of cars with nailhead spot.......... 44
Number of cars of tomatoes inspected.......482

The relative importance of these troubles in the various states is indicated as follows:

__Slight__ - Rhode Island, Connecticut, New York, Delaware, North Carolina, South Carolina, Ohio, Indiana, Michigan, Wisconsin, Minnesota, Iowa.

__Moderate__ - Pennsylvania, Virginia, Maryland (2%), Mississippi (1-5%), Texas (2%).

__Severe__ - Massachusetts, New Jersey, West Virginia (10%), Florida, Louisiana (10%), California (4%).

The following comments from collaborators give the situation for 1921. (See also Pl. Dis. Bul. 5: 54. 82-83, 117. 1921).

__New Jersey__: Alternaria leaf blight and fruit rot was prevalent throughout New Jersey in 1921. The fruit rot was very important on the last pickings. September 19th, one field of late crop Baltimore tomatoes was examined and at this time the Alternaria fruit rot

infection was found to vary from 1 to 21%. The disease on the foliage caused much damage in some localities but was of minor importance in comparison to the disease of the fruit. (Poole).

Louisiana: The early blight of tomatoes, or nailhead spot as it is sometimes called, is a very important disease in southern Louisiana. The principal damage is from the leaf stage as many varieties are completely defoliated in the Gulf region. Next to wilt, this is our most serious tomato disease. (Edgerton, Jan. 15, 1922).

Texas: Prevalent, 2% loss. (Taubenhaus).

Indiana: Not important. Worse in southern Indiana. Serious infection noted on staked Bonny Best in market garden. (Gardner).

California: Early blight was more severe this year than for four years. The disease attacked the petioles and small stems as well as the leaves. Loss for state 4%. (Milbrath).

First appearance of early blight of tomato, 1921

May 21.................. Wood County, West Virginia
July 15.................. Delaware
September 1............. Madison, Wisconsin
September 9............. Calhoun, South Carolina

Mosaic (cause undetermined)

There has been some question as to the potential seriousness of tomato mosaic, but from the results of recent work it seems to be worthy of close attention. Gardner and Kendrick[1], and Melhus[2], have established the importance of the common perennial solanaceous weeds, Physalis spp. and Solanum carolinense, in carrying the disease through the winter, and, as new lands are used for tomatoes, in providing sources of infection which make the production of a crop increasingly difficult.

In 1921, the usual scattered reports of the occurrence of mosaic in greenhouses were made. In New York, Illinois, and Oregon it was a serious disease of tomatoes under glass, and in Ohio, while it occurred locally in truck sections, it caused greatest losses to the greenhouse crop. Chupp reports as much as 20% in one greenhouse and 50% in another in Ithaca; while in Oregon as much as 100% of the plants were affected in some houses, with a 50 to 75% reduction in yield, although the loss for the state was slight.

The disease was reported on field-grown tomatoes in Connecticut, Rhode Island, New Jersey, Pennsylvania, Virginia, West Virginia, Kentucky, Louisiana, Arkansas, Ohio, Indiana, Iowa, Kansas, and California. In Connecticut, according to Clinton it was lessprevalent than in 1920. In Rhode Island it was said to be common in some gardens, but not generally serious. Cook reports it as more abundant in New Jersey than formerly, and R. F. Poole makes the following statement concerning conditions in that state:

"The mosaic and filiform disease of tomatoes is prevalent and the cause of heavy losses in all localities of New Jersey. The disease has persistently caused heavy losses of tomatoes growing in the field and also in the greenhouse. The latter crop has been very largely abandoned in some localities. Aphid infestation of tomatoes has been important on tomatoes in this state for several years. This infestation is no doubt related to the amounts of distribution, prevalence, and loss due to mosaic and filiform."

Thurston and Orton report a field in Center County, Pennsylvania, which showed 100% mosaic. F. J. Pritchard states that most fields at the Arlington Experimental Farm showed 100% of the plants affected by mosaic. The disease is said to be of slight importance in West Virginia. Valleau reports 100% infection at the Experiment Station in Kentucky, Edgerton states that the disease was very common and serious in nearly all tomato plantings in Louisiana. Elliott says that the disease was less prevalent in Arkansas. Gardner considers the disease worse in Indiana than it was in 1920 and states that it is a serious factor in the canning crop, due to early infection which reduced the yield. Mosaic was a very important trouble in Iowa, according to Melhus, and Melchers reported it as very common and causing loss of production in most fields in Kansas. D. G. Milbrath states that mosaic is on the increase in California. The symptoms extend from the fern leaf condition to mottling and rolling. Affected plants set little fruit.

Losses reported by collaborators were as follows: New York, trace to 5% (greenhouse); Arkansas, 3%: Indiana, 2%: Iowa, 11%: Oregon, slight (greenhouse); California, 1%.

The disease was first observed on the following dates:

February 24.............. Ithaca, New York (Greenhouse)
April 13................. Riley, Kansas
May...................... Louisiana
May...................... Corvallis, Oregon (Greenhouse)
June 10.................. Lafayette, Indiana
August................... Westville, Connecticut

Literature cited

1. Gardner, M. W. and James B. Kendrick. Overwintering of tomato mosaic. (Abstract) Phytopath. 12: 41-42. Jan. 1922.
2. Melhus, I. E. Mosaic studies. (Abstract) Phytopath. 12: 42. Jan. 1922.

Late blight caused by Phytophthora infestans (Mont.) De Bary

No report of this disease given extends the range published in last year's report. The hot, dry season was commonly reported as being responsible for lessening its prevalence. The following comments from collaborators are of interest:

Pennsylvania: Reported only from Luzerne County this year. (Thurston and Orton).

West Virginia: Much less than last year, causing slight reduction in yield. The range was local in the higher altitudes of Tucker and Upshur Counties. First seen August 15 in Upshur County. Good control obtained with Bordeaux 5-5-50. (Giddings).

North Carolina: Very destructive in mountainous sections at elevations above 3,000 feet. (Foster).

According to Colin G. Welles[1], late blight of tomato is an important disease in the Philippine Islands, at Trinidad in the Mountain Province. (See also under potato mosaic).

Literature cited

1. Welles, Colin G. Plant diseases found at Trinidad, December 1921. Philipp. Agr. 10: 348-349. Febr. 1922.

Bacterial wilt caused by *Bacterium solanacearum* EFS

This disease was reported as doing slight damage in a number of the southeastern Coast States. In loss of production it was pronounced less important in 1921 than in the preceding season.

E. F. Smith[1] states: "In the United States it occurs from Maryland and New Jersey south to Florida, Cuba, and Porto Rico, but its northern and western distribution in this country are unknown. It seems to thrive best in the eastern United States in washed river sands."

The accompanying map (Fig. 78) summarizes the distribution records of the Plant Disease Survey.

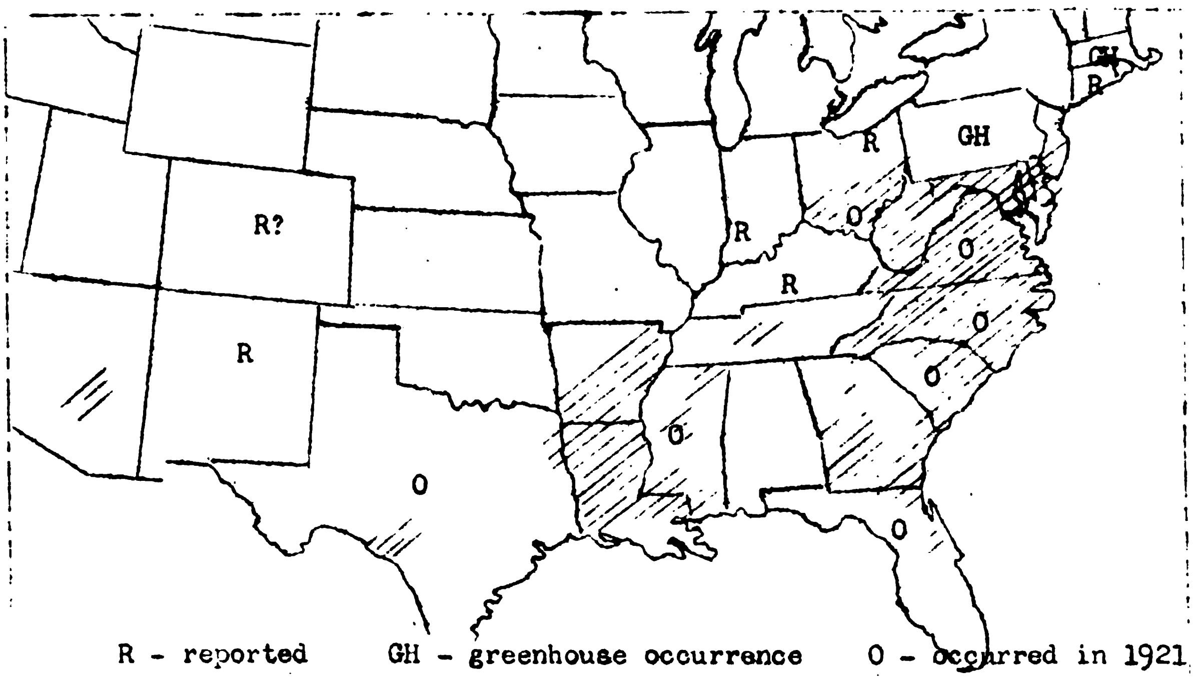


Fig. 78. Distribution of bacterial wilt of tomato as reported to the Plant Disease Survey, 1903-1921.

The damage done in 1921 was slight, with the possible exception of the North Carolina crop, as is evidenced by the following comments of collaborators:

Connecticut: One doubtful case. (Clinton).

Virginia: Occasional, severe when it does occur. (Fromme).

Kentucky: One suspected case. (Valleau).

North Carolina: Destructive in several counties. Five percent loss. (Foster).

South Carolina: Greatest loss is due to necessity of leaving tomatoes completely off infected soil. (Ludwig).
Northwestern half is heavily infested. (F. J. Pritchard).

Florida: Slight in amount, complete loss in some fields. (Burger).

Mississippi: One field observed. (Neal).

Ohio: Less frequent; present in limited extent in all greenhouses, less serious in field. (Selby).

California: Not observed; may be present. (Milbrath).

Literature cited

1. Smith, E. F. Bacterial diseases of plants. 1920 p. 182.

Blossom-end rot (non-parasitic)

The distribution of blossom-end rot in 1921 is indicated on the accompanying map (Fig. 79). It will be noted that Arizona reported it as occurring in 1921 for the first time.

In some sections high temperature and drouth made this disease severe, but in the majority of tomato growing sections the drouth was broken during the tomato ripening period and for the central-western states blossom-end rot was less than usual. The drouth effects seem most important in producing the break-down when operative at time of maximum fruit expansion, and blossom-end rot, while appearing on fruit of a certain size, may be totally absent from both younger and older sets.

The comparative prevalence of the disease and losses caused by it are shown in Tables 70 and 71.

Table 70. Comparative prevalence of blossom-end rot of tomatoes, 1921.

States reporting same or less damage for 1921 than for 1920	States reporting more loss in 1921 than in 1920
Vermont, Pennsylvania, Virginia, West Virginia, Ohio, Indiana, Illinois, Wisconsin, Minnesota, Iowa, North Dakota, Kansas, Idaho, Washington and California.	New York, South Carolina, Georgia, and Mississippi.

Table 71. Losses caused by blossom-end rot of tomato, as estimated by collaborators, 1921.

State	Percent of Crop	State	Percent of Crop
New York	3-10	Indiana	.2
South Carolina	5	Minnesota	t
Georgia	20	Iowa	1.
Mississippi	20	Kansas	1.
Texas	4	Oregon	Slight
Arkansas	3	California	6.
Ohio	1-2		

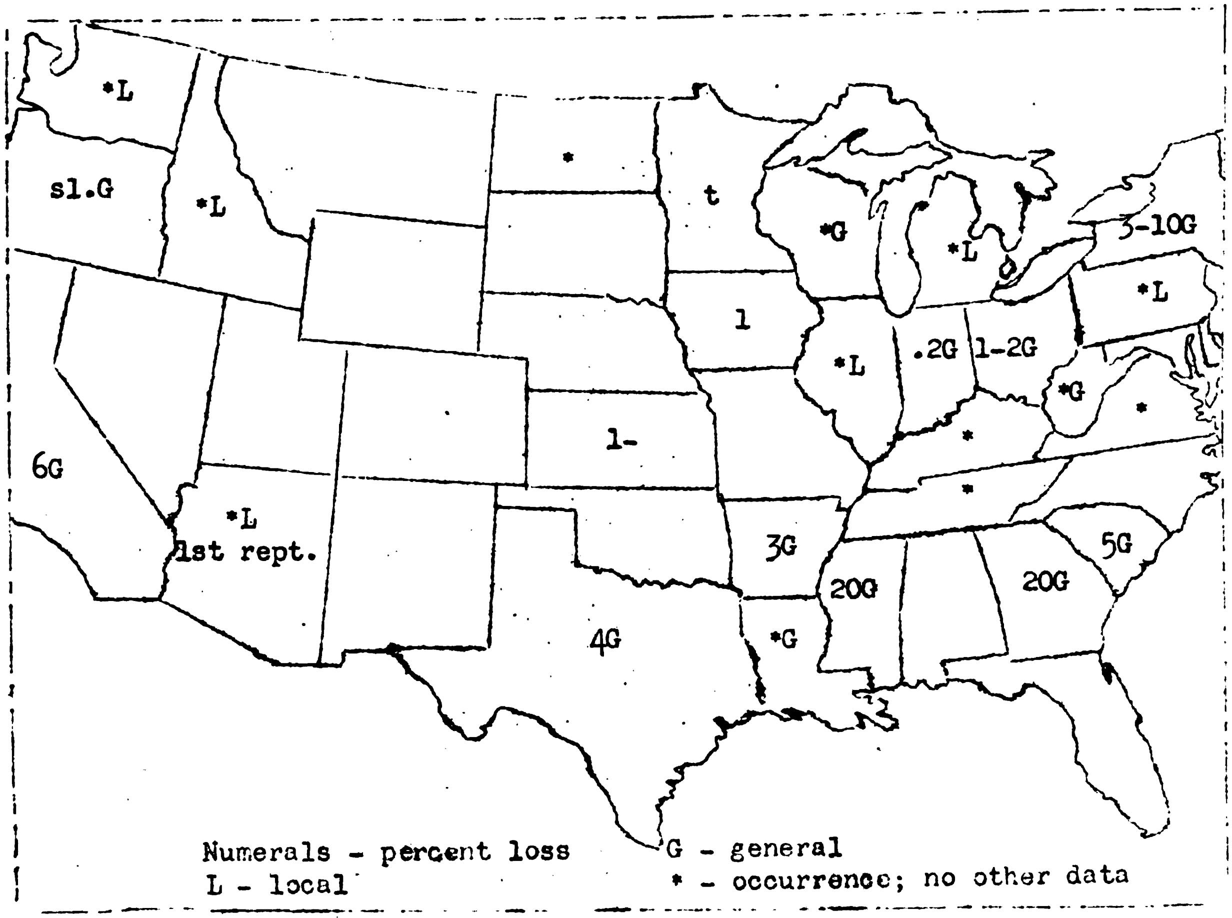


Fig. 79. Occurrence of and losses from blossom-end rot of tomato as reported to the Plant Disease Survey, 1921.

Dates of first appearance

June 23....Freewater, Oregon
July 11....Chautauqua, Kansas
July 14....Stark County, Ohio
August 25.....Madison, Wisconsin
September 15...Tucson, Arizona
September 25...Burlington, Vermont

Varietal differences

No special reports on varietal resistance were made by collaborators. In response to a questionnaire it was brought out that Bonny Best, although commonly considered resistant to blossom-end rot, did not seem especially so in many sections this year. Growers in the South are interested in a variety called "Gulf State", which is resistant to blossom-end rot and to weather cracking (catface). The following comments are illuminating:

Virginia: It is the general opinion among the growers that Bonny Best is quite resistant and this variety is planted for canning purposes in the Roanoke section for this reason. (Fromme).

Tennessee: It may be stated that Professor Essary's selection of wilt-resistant tomato from Livingston's Beauty, had been selected also for blossom-end rot resistance, and according to some information at hand is comparatively very little affected with this trouble. (Sherbakoff).

Georgia: Bonny Best is not extensively grown in this state, but it was observed that the varieties like Globe were less subject to blossom-end rot than some of the larger fruited varieties. (McClintock).

Ohio: We have not found the Bonny Best variety any more resistant than others, and I do not know of any variety which shows sufficient resistance to the point rot disease to be worthy of mention. The effect of the dry weather in some sections was manifest after another fashion; namely, by cracking, both radial and circular, of the skin of tomatoes, especially in the region of the stem end, and frequently observed on all parts of the fruit. This resulted in more serious losses than point rot, and interfered with marketing because so many leakers developed. This physiological disease was estimated at 4%. (Thomas).

Indiana: The Indiana canning crop suffered less from blossom-end rot during the last season than in the two preceding seasons. We had heavy rains during August and September, much heavier than in normal years, and these are the months when the crop is ripening. We have not noted that the Bonny Best variety is resistant to blossom-end rot. The Horticultural Department is trying to develop a resistant strain of the Greater Baltimore canning variety. (Gardner).

Buckeye rot caused by Phytophthora terrestria Sherb.

Collaborators reported buckeye rot from Tennessee and Indiana. Sherbakoff states that Tennessee tomatoes suffered mostly from buckeye rot, brought about by a prolonged rainy spell at a time when most of the fruit was set. The loss for the state was placed at approximately 10%. The disease was not so important as wilt or Septoria blight. Gardner reports the

disease as destructive in a garden at Lafayette, Indiana, appearing August 1 and doing greatest damage in September. Excessive rainfall favored the disease. Pritchard reports this rot as occurring in small amounts in most fields at the Arlington Experimental Farm. In one field at least 50 or 60% of the fruit was infected during a wet period.

Damping-off caused by Pythium spp.

Damping-off doubtless occurred here and there in the various states, but is reported only from Connecticut where it occurred April 11 at Westville. In this connection it is important to call attention to recent contributions from an English worker. W. F. Bewley[1,2] reports control by watering with a copper sulphate and ammonium carbonate compound. The original should be consulted for details. He also indicates the possibilities of introduction of the organism with the seed.

Literature cited

1. Bewley, W. F. "Damping off" and "foot rot" of tomato seedlings. Ann. Appl. Biol. 7: 156-172. Dec. 1920.
2. ___________ Control of "damping off" and "foot rot" of tomatoes. Jour. Min. Agr. Gt. Brit. 28: 653-654. Oct. 1921.

Phoma rot caused by Phoma destructiva Plowr.

Phoma rot was reported only from South Carolina and West Virginia. occurring locally in both states. This disease, which may be minor in the state of origin, becomes very important with tomatoes in transit as is evidenced by the accompanying table (Table 72) showing market losses.

Table 72. Losses from Phoma rot caused by Phoma destructiva, as shown by examination of cars at destination by food-products inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Remarks as to seriousness of decay
Arizona	1	6	1	6	
California	19	20	2	77-95	Some Rhizopus rot present
			6	15-30	Associated with other decays
			6	5-12	" " " "
			5	2-4	" " " "
Florida	116	12	1	83	Some Rhizopus rot present
			25	20-45	Associated with other decays
			64	5-18	" " " "
			26	2-4	
Illinois	1	8	1	8	Phoma and soil rots, advanced
Maryland	2	39	2	8-70	Mostly anthracnose in one car

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Remarks as to seriousness of decay
Mississippi	25	6	10	5-15	
			15	2-4	Associated with other decays
Tennessee	3	5	3	2-8	
Texas	11	10	8	6-20	Associated with other decays
			3	2-4	
Mexico	10	7	10	2-20	
West Indies	2	23	2	11-35	
Unknown	2	3	2	1-6	

Total number of cars with Phoma rot............ 192
Total number of cars of tomatoes inspected..... 712

Bacterial spot caused by Bacterium vesicatorium Doidge (Bacterium exitiosum Gardner & Kendrick)

This disease whose causal organism was described almost simultaneously by Miss Doidge and by Gardner, is given here under the prior name. Gardner states, "Miss E. M. Doidge published a few months ahead of us. The organism is the same, hence her binomial takes precedence."

Distribution in general has been southern extending as far north as central Michigan. It is reported in 1921 as less important in Indiana than in previous years, causing .2% loss. It was found in eleven out of 76 fields in central Indiana, putting in its first appearance on July 2 in Howard County. Seed disinfection is reported as giving fair control. The disease caused considerable injury in greenhouses in Kansas according to Melchers.

Milbrath of California reports a similar spot as causing .1% loss in California.

The following references will give access to the literature on this disease:

Doidge, E. M. A tomato canker. Ann. Appl. Biol. 7: 407-430. Illus. pl. xxvi. Febr. 1921, no. 4. References: p. 429-430.
Gardner, Max W. and James B. Kendrick. Bacterial spot of tomato. Jour. Agr. Res. 21: 123-156. April 15, 1921.

Winter blight (cause unknown)

Winter blight (also called stripe or streak) was reported from New York, New Jersey, Pennsylvania, Michigan, and Ontario. In general it was confined to the greenhouse crop. No figures on loss are given by collaborators, but past records for Pennsylvania and Michigan indicate the disease may be serious. Stone and Howitt[3] state that the disease is common in tomatoes under glass in Ontario, often causing serious losses and in some instances making the production of a profitable winter crop of tomatoes

impossible. They report that no pathogen seems responsible and that the disease is a result of soil conditions. "During the past five years almost uniformly satisfactory results have been obtained in the control of this disease by the addition of phosphoric acid and potassium to the soil."

A similar disease, of considerable importance in England, has been attributed by Paine and Bewley[1,2] to Bacillus lathyri Manns & Taub.

Recent literature

1. Bewley, W. F. Stripe disease of tomato. Nursery and market garden. Ind. Dev. Soc. Exp. & Research Sta. Ann. Rept. 1920: 44. 1921.
2. Paine, S. G. and W. F. Bewley. Studies in bacteriosis. IV. - "Stripe" disease of tomato. Ann. Appl. Biol. 6: 183-202. Pl. 8-9, 5 fig. 1919. (Abstr. by G. R. Bisby in Bot. Absts. 5: Entry 756. Aug. 1920.)
3. Stone, R. E. and J. E. Howitt. Experiments with winter blight or streak of tomatoes. (Abstract) Phytopath. 12: 41. Jan. 1922.

Leaf mold caused by Cladosporium fulvum Cke.

Cladosporium fulvum, which has previously been reported to the Survey from all except the mountainous western states was reported in 1921 from both field and greenhouse in its usual range. Browning of Rhode Island found the disease in some gardens, but not as conspicuous as last season. Leaf mold caused considerable defoliation in the fields at the Arlington Experimental Farm during the past two years, and at the Experiment Station in Kentucky in 1921, according to Pritchard and Valleau, respectively. Dana reported it from Walla Walla County, Washington. Michigan, Indiana, Iowa, and Ohio reported the disease on the greenhouse crop. In Ohio the disease was of considerable importance as usual in hothouses, and was invariably noticed to be serious when ventilation was inadequate, according to R. C. Thomas. Gardner reports that leaf mold is serious only in greenhouses in Indiana. Coons states that the greenhouse crop in Michigan was cut off one month early by a sudden outbreak of the disease which checked the crop early in July and caused a much greater loss than usual. The disease is not commonly held in the proper light by gardeners who usually consider it unimportant, and make no effort to control it.

Reference

Makemson, W. K. The leaf mold of tomatoes caused by Cladosporium fulvum Cke. Rep. Mich. Acad. Sci. 20: 309-348. pl. xxiii-xxxvii. 1918.

Fruit rot caused by Rhizopus sp.

Rot of tomatoes caused by Rhizopus sp. is reported from Texas (Rhizopus nigricans; traces), and from California by Milbrath as follows:

> "Rot caused by Rhizopus is a field disease. Fruit not only rots in the field but also carries infective material from the field. Loss in field about 1%."

Table 73. Losses from Rhizopus rot of tomato, as shown by inspection of cars at destination by food products inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Remarks
Alabama	3	9	3	5-17	Advanced stage
Arizona	1	4	1	4	Mostly soil rot
California	23	13	1	77	Mostly Phoma rot
			2	25-30	Associated with other decays
			14	5-18	Other decays in some cars
			6	2-4	
Florida	193	8	1	83	Mostly Phoma rot
			6	25-45	Associated with other decays
			133	5-20	Other decays in some cars
			53	2-4	
Mississippi	39	6	21	5-22	Associated with other decays
			18	2-4	" " " "
New Jersey	1	18	1	18	Some fruit rot
Ohio	1	7	1	7	
South Carolina	1	3	1	3	
Tennessee	7	12	1	30	Rhizopus and anthracnose
			6	5-10	
Texas	78	11	3	35-50	Associated with other decays
			17	15-25	" " " "
			42	5-13	" " " "
			16	2-4	
West Virginia	1	6	1	6	Generally complete
Canada	1	2	1	2	Early stages
Mexico	30	6	20	5-20	Associated with other decays
			10	2-4	
West Indies	3	11	3	5-15	
Unknown	2	12	2	10-13	

Total number cars of tomatoes with Rhizopus rot.... 384
Total number cars of tomatoes inspected............ 712

New diseases

Two new conditions are reported by Milbrath from California as follows:

Calico spotting, cause unknown. Spotting of fruit in the form of alternation of red and white has increased rapidly during the past four years, and bids fair to become a very important problem. At least 5% of all fruit produced in the fields was spotted. If I were to form an estimate of spotting from the amount found on the markets, it would easily run to 15%.

Blossom end stain, cause unknown. This disease differs from the commonly known blossom end rot in that the affected area at the blossom end consists of numerous small blotches which later coalesce to form a green-yellow area.

The affected portion does not turn black as in the case of blossom end rot. Three percent of the crop of the state was affected.

Other diseases

Anthracnose caused by Colletotrichum phomoides (Sacc.) Chester was reported as being less prevalent than usual in New Jersey and Indiana.

Collar rot, caused by various fungi. According to Pritchard[1], stem girdling at the surface of the ground may be caused by at least three fungi, Verticillium lycopersici Pritchard & Porte, Macrosporium solani E. & M., and Rhizoctonia solani Kühn. It was reported by them as occurring in 1917, 1918, and 1919 in Maryland, New Jersey, and Delaware in seedbeds and on newly set plants. The following additional 1921 report of this type of disease extends the range:

> Indiana: Serious in one field. Blackened stem lesions at ground line, probably result of seedbed infection with Macrosporium solani E. & M. First seen July 6 at Greenfield. (Gardner).

Literature cited

1. Pritchard, F. J. and W. S. Porte. Collar rot of tomato. Jour. Agr. Res. 21: 179-184. May 1921.

Stem girdle caused by Phytophthora (species not determined). This disease, newly described by Reddick (A fourth Phytophthora disease of tomato. Phytopath. 10: 528-534. Dec. 1920.) is reported from New York as follows: "One greenhouse crop discarded entirely due to this disease." (Chupp).

Root knot caused by Heterodera radicicola (Greef) Müll. Reported from West Virginia, South Carolina, Texas, Louisiana, Ohio, Arizona, and Washington, being found in South Carolina, Texas, Louisiana, and Arizona as a field disease. South Carolina (Ludwig) reports the range as general with about the usual loss. Taubenhaus reports 1% loss to the tomato crop in Texas. Edgerton of Louisiana reports the disease as very serious in some localities.

Leaf roll (cause unknown). New York, Pennsylvania, and Kentucky report a leaf roll condition which is worthy of further investigation. Leaf roll of tomato has been known since Rolfs' earlier studies, but investigation as to its cause has not been made. A report by Güssow (Leaf curling in tomatoes. Phytopath. 11: 380-383. 1921). assigns a leaf roll condition to unbalanced conditions brought about by heavy pruning. Regarding this rolling of leaves, Pritchard of the United States Department of Agriculture writes as follows:

> "The leaf roll caused by heavy pruning or excessive watering appears to be only a physiological reaction, as the leaves remain green and seem to function normally. This appearance is very striking in some foreign varieties grown in the United States without pruning or excessive watering. It is not usually regarded as a disease.
>
> "The other leaf roll, resembling leaf roll of potatoes, is quite different, resembling somewhat Western blight, but without the yellow appearance of the foliage and the decortication of the rootlets. Moreover, these plants are very unfruitful."

Soft rot of the green fruit (bacterial) caused 50% loss in home gardens at Blacksburg, Virginia. (Fromme).

Fruit rot caused by Glomerella rufomaculans (Berk.) S. & S. was reported collected in a garden at Ithaca, New York by L. M. Massey.

Wilt caused by Sclerotium rolfsii Sacc. reported by Edgerton as serious during July and August in the river districts in Louisiana, especially the northeastern portion.

Summer blight (cause unknown) was reported by Milbrath as less important than usual in California.

Wilting, brought about by influence of walnut trees, was reported for New Jersey by Cook (Wilting caused by walnut trees. (Phytopath. 11: 346. 1921.) and for Michigan by Coons, three instances being seen with black walnut and Gulf State tomato on July 5 and 6.

Weather effects were noted by several collaborators. Many commented upon the reduction of crop brought about by the drouth. Texas and Ohio report "blossom drop" as prevalent, dry air conditions seemingly interfering with pollination.

Sunscald did some damage in Indiana chiefly in opening the way for secondary invaders.

Growth cracks and catface. Important in Indiana, causing loss from blemishing and from secondary rots which followed. Gardner estimates loss from catface at .2% of crop and from growth cracks at 6%. "Late rains lead to cracking and infection." Thomas of Ohio reports as follows: "Conditions were much the same. A very large part of the tomato crop throughout the early and mid-season was lost due to cracking which occurred in the epidermis both radial and circular, thought to be due to dry weather. These resulted in a very large number of leakers which very seriously interfered with the handling and shipping of the crop." Lutman of Vermont reports, "Skin of fruit splits in rings around stem due to slow growth in August followed by September rains. Fungus infection follows."

Hydrocyanic acid injury was described by Potter, G. F. (Hydrocyanic acid injury to tomatoes. Proc. Amer. Soc. Hort. Sci. 17: 120-126. 1921) and it was reported by Gardner from Indiana, "Crinkling and distortion of younger leaves accompanied by downward curling. Noted following fumigation for insects."

Tobacco fume injury also was reported by Gardner as causing angular, intervenous, white spots on leaves.

DISEASES OF SWEET POTATO

Stem rot caused by Fusarium batatatis Woll. and F. hyperoxysporum Woll.

Sweet potato stem rot was probably the worst disease of sweet potatoes in 1921. The report for 1920 indicated a smaller loss than occurred during the 1921 season. Dry weather and high temperatures are suspected of being factors in increasing the loss from this source. The disease was reported from New Jersey, Delaware, Maryland, Virginia, Kentucky, Tennessee, North Carolina, Florida, Mississippi, Louisiana, Texas, Arkansas, Indiana, Iowa, Missouri, Kansas, and Arizona. The following table (Table 74) lists the losses reported:

Table 74. Losses from stem rot of sweet potatoes in 1921, as estimated by collaborators.

Percent loss	State
20	New Jersey
15	Mississippi, Kansas
10	North Carolina
8	Delaware
6	Iowa
5	Maryland
2	Virginia, Arkansas
1	Indiana
Trace	Florida, Louisiana, Texas

The following statements from collaborators indicate the conditions observed in the different states:

Mississippi: More prevalent than in 1920; found in 40% of the plantings in the state, affecting 10% of the plants. First seen June 10 at Meridian; becoming common. (Neal).

Arkansas: Less prevalent than last year. Found in 75% of the fields of the state, affecting up to 25% of the plants. First seen in June. (Elliott).

Indiana: Less prevalent than last year. First seen June 22 in Boone County. (Gardner).

Kansas: Worse this year than last. The disease is on the increase; found in eastern, southern, and central Kansas. First recorded May 21 in Wyandotte County. (Stokdyk).

Difference of opinion seems to exist among collaborators as to resistance of various varieties. Cook and Poole[1] report that Big Stem varieties are more resistant than smaller stem varieties. However, conditions quite the reverse are reported from Virginia (Harter). Neal reports very few varietal differences in susceptibility noted in Nancy Hall, Porto Rican, or Triumph. Stokdyk reports fields of Yellow Jersey and Nancy Hall badly infected, while the variety Porto Rico was free. Gardner reports disease severe in Yellow Jersey but not present on White Yams.

Some promise is given of control by seed selection; Cook and Poole reporting that seed selected at digging time produced slightly better sprouts than unselected seed set on infected soil. Elliott reports that seed and slip certification has established some dependable sources of seed and given some large fields free from wilt. Neal reports that the disease is becoming very general in Mississippi in spite of quarantine and preventive measures.

Literature cited

1. Cook, Mel T. and R. F. Poole. Stem rot diseases of sweet potatoes in New Jersey. Phytopath. (Abstract) 12: 51. 1922.

Black rot caused by Sphaeronema fimbriatum (E. & H.) Sacc.

Black rot was generally prevalent again this year, losses ranging from a trace to as high as 15% of the crop, as is shown in the following table.

Table 75. Losses from and prevalence of black rot of sweet potatoes in 1921, as reported by collaborators.

State	Percent loss	Remarks
New Jersey	2	Abundant. (Cook).
Delaware	1	Stand cut by early sprout infection. (Adams).
Maryland	1	Less. (Jehle and Temple).
Virginia	5	Moderate to severe, especially on late crop at Norfolk. (Fromme).
Kentucky	-	Considerable. Treated seed produced fairly clean crop. (Valleau).
Tennessee	-	Common, not serious. (Essary,Hesler,& Sherbakoff).
North Carolina	6	Considerable; especially in storage houses.(Foster).
South Carolina	.5	Less. (Ludwig).
Georgia	-	Reported.
Florida	-	Prevalent in all parts of state. (Burger).
Mississippi	15	Nancy Hall is most susceptible. (Neal).
Louisiana	-	Quite serious. (Edgerton).
Texas	5	
Arkansas	5	Mostly storage trouble. (Elliott).
Indiana	2	Field and storage rot. (Gardner).
Illinois	-	Prevalent. (Bierbaum).
Iowa	5	
Kansas	2-3	

Seed treatment coupled with rigid selection of blemish free seed-stock seems to be of considerable promise as shown by favorable reports from Kentucky, Georgia, Mississippi, Arkansas, and Kansas. Neal from Mississippi, for example, reports that the healthy seed-stock campaign has reduced to a surprising degree the amount of infection on the plant. Strict quarantine regulations are causing plant growers both within and outside of the state to make greater efforts to produce healthy plants.

Pathologists and inspection officials in certain Southern states are proposing a uniform inspection and certification system. The following report by L. L. Harter outlines the present status of the movement:

> "With respect to the sweet potato seed inspection and certification work, I would say that I returned a few days ago from the meeting of the southern agricultural workers at Atlanta, Georgia. The question of sweet potato seed inspection and certification was rather thoroughly gone into and a committee was appointed to draw up a uniform system of inspection and certification for the sweet potato districts of the South.
>
> "The states of Arkansas, Mississippi, and Georgia have already in operation a system of seed inspection. In the states of Arkansas and Georgia it is voluntary, while in Mississippi it is complusory.

This committee seems to be of the opinion that a minimum requirement should be uniform throughout the southern states and that the inspection should largely be voluntary. It is believed that the chief benefits derived from this system would result from the creation of a demand among the consumers for clean seed. If a uniform system of certification can be adpoted, to which all the people concerned throughout the different states will agree, it would enable the shippers to send the potatoes or plants from one state into the other, provided they carried a certificate from the proper certified officers of that state." (March 3, 1922).

Heavy rot in a storehouse with forced ventilation system was reported by Elliott in Arkansas.

Losses from black rot, associated in many instances, to be sure, with decays of other sorts, have been compiled from reports of car inspectors (Table 76). These reports show the tremendous importance of the disease as a market problem. It is very evident that loss in the field is but a small percentage of the total loss levied upon the crop from this cause. The development of general and efficient control regulations seems well warranted from this showing of the importance of this disease.

Table 76. Losses from black rot of sweet potato caused by Sphaeronema fimbriatum as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Remarks
Alabama	1	8	1	8	Some Rhizopus rot
Arkansas	2	10	2	2-18	
Delaware	2	8	2	6-10	
Georgia	18	13	2	45-63	Associated with other decays
			7	9-25	
			9	2-4	
Indiana	1	3	1	3	Black rot and foot rot
Louisiana	3	4	3	2-6	
Maryland	5	3	5	2-5	Some Rhizopus rot in one car
Mississippi	1	77	1	77	In large spots
North Carolina	1	14	1	14	Black rot and dry rot
South Carolina	1	11	1	11	
Tennessee	2	7	2	1-13	Mostly Rhizopus in one car
Texas	1	12	1	12	
Virginia	4	20	1	70	Severe decay
			3	1-5	
Unknown	2	16	2	10-22	

Total number of cars of sweet potatoes with black rot... 44
Total number of cars of sweet potatoes inspected........ 245

Soft rot caused by Rhizopus spp.

Losses from soft rot are important in New Jersey, Maryland, Florida, Texas, Arkansas, Iowa, and Kansas. Potatoes exposed for sale in markets

generally suffered heavy shrinkage from this factor as is brought out by the inspection reports from the Bureau of Markets and Crop Estimates. Research by Lauritzen and Harter[1] indicate that Rhizopus tritici and Rhizopus nigricans are chiefly responsible for the decay, R. tritici working at the higher temperatures and R. nigricans at the lower, the two over-lapping between 20° and 30°C. Other species are also factors in rotting. Because of its temperature relations R. nigricans is the principle agent of decay. Elliott reports that better storage facilities have greatly reduced losses, which may be high as is evidenced by a report from Stokdyk in Kansas that there some storage houses poorly ventilated showed one-half loss due to this disease.

Recent literature

Cited

1. Lauritzen, J. I. and L. L. Harter. The species of Rhizopus responsible for the decay of sweet potatoes under storage conditions. (Abstract) Phytopath 12: 51. Jan. 1922.

Not cited

Harter, L. L., J. L. Weimer, and J. L. Lauritzen. The decay of sweet potatoes (Ipomoea batatas) produced by different species of Rhizopus. Phytopath. 11: 279-284. July 1921 (Nov.).

Weimer, J. L. and L. L. Harter. Respiration and carbohydrate changes produced in sweet potatoes by Rhizopus tritici. Jour. Agr. Res. 21: 627-635. Aug. 1, 1921.

Soil rot caused by Cystospora batata Elliott

Soil rot is said not to occur in Tennessee and Mississippi, and in Louisiana it was found for the first time this year, according to Edgerton. Collaborators reported as follows:

Delaware: First observed August 10. Heavy infection on soil planted continuously to sweet potato for ten or more years. Plants easily recognized by retarded growth and root system severely crippled. In some fields 100% of stand infected. Loss for state 2%. (Adams).

New Jersey: Infection about 75% in restricted areas. Not general. Loss sometimes 50%. (Cook).

Maryland: Five-tenths percent reduction in yield for state. (Temple and Jehle).

Virginia: Unusually prevalent throughout the state. (Fromme).

Louisiana: Occasional. First report in state. (Edgerton).

Texas: Trace. One percent reduction in yield for state. (Taubenhaus).

Kansas: Only a trace in a very few fields. (Melchers).

Scurf caused by Monilochaetes infuscans Hals.

Sweet potato scurf was present in practically the same amount as in other years, producing serious blemish rather than reduction in yield. The figures given in the following table are to be interpreted from the point of view of lowered market value rather than direct effect to the crop.

Table 77. Losses from scurf of sweet potato, as estimated by collaborators.

State	Percent loss	State	Percent loss
Maryland	.5	Kansas	2% in Arkansas Valley
Mississippi	2.	Arizona	Very important
Arkansas	t		

Seed treatment was reported by Elliott as effective in Arkansas. The report from Kansas is the first for that state, although E. A. Stokdyk believes the fungus has undoubtedly been present for some time. It was first found August 3 in Reno County. In Arizona, Brown calls attention to the relation of heavy soils to heavy infection and reports that the blemish is often followed by Rhizopus rot. The disease was first seen October 26 at Casa Grande, Arizona.

Other diseases

White rust caused by Albugo ipomoeae-panduranae (Schw.) Swingle was reported as unimportant from New Jersey, Delaware, and Arkansas, and from North Carolina by Foster as follows: "Found in one section to be very destructive and causing considerable defoliation. This is evidently the first report of this disease causing considerable damage."

Leaf spot caused by Phyllosticta batatas Cke. was reported from South Carolina as negligible.

Leaf spot caused by Cercospora batatae Zimm., a very serious Chinese disease, was found during 1921 at the College of Agriculture in the Philippine Islands, according to Colin G. Welles (Philip. Agr. 10: 253-254. Dec. 1921). A species of Cercospora which has not been determined but is possibly the same one was found by Welles in the important trucking section at Trinidad in the Mountain Province, also, but it was not severe.

Mosaic (cause unknown) was reported from Arkansas by Rosen as present to a limited extent in almost every field inspected, according to G. G. Becker, Chief Inspector, Arkansas Plant Board.

Root rot caused by Ozonium omnivorum Shear was reported only from Texas (very prevalent, loss 10%. - Taubenhaus).

L. L. Harter (Farmer's Bul. 1059, page 16) makes the following comment concerning this root rot: "Root rot, so far as known, occurs only in Texas, New Mexico, Oklahoma, and Arizona. When the disease once gets into a field, a whole crop may be destroyed. Large fields have been seen in which not more than 10% of a crop was produced..... The organism lives from one season to the next in the soil on dead vegetable matter, or in the far South probably on growing winter crops. It is killed by hard freezing, and this alone probably restricts the disease to the Southern states."

Foot rot caused by Plenodomus destruens Harter was reported from Maryland, Tennessee, North Carolina, Florida, Mississippi, and Kansas, and was definitely reported as not known to occur in South Carolina, Louisiana, and Texas. In general, it was of minor importance, producing loss in only a few localities, for example, from Tennessee 33% loss was reported by Essary, Sherbakoff, and Hesler. In other localities the loss was slight.

L. L. Harter (Farmer's Bul. 1059, page 12) makes the following statement as to occurrence and prevalence: "Foot rot is known to occur in Virginia, Iowa, and Missouri, and it is likely that it occurs elsewhere. Owing to the fact that it is not so widely distributed, the total loss that may be attributed to this disease is much less than with black rot and stem rot. In localities where it does occur, however, it produces greater loss than either of these diseases. In certain sections of Virginia, Ohio, and Iowa, it has been estimated to produce a loss of 50% of the crop in one year."

Rot due to Trichoderma koningi Oud. was reported present in Delaware.

Java black rot caused by Diplodia tubericola (E. & E.) Taub. was reported from Texas where it caused .5% damage.

Rot caused by Sclerotium rolfsii Sacc. was reported from Dallas County, Texas.

Charcoal rot caused by Sclerotium bataticola Taub. was reported from Delaware and Texas.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported as fairly severe in Arkansas, being found in 15% of the plantings, affecting on an average 10% of the plants and reducing the yield of sweet potatoes for the state about 3%. (Elliott).

Internal breakdown (non-parasitic). Collaborators have occasionally reported occurrence of flesh discolorations in sweet potatoes which simulated conditions known for other crops. The following statement by L. L. Harter was made concerning specimens received from Georgia (1920 crop): "There is a breaking down of certain physiological conditions which is not well understood. The internal breakdown occurs generally at the latter end of the storage period, along about March or April. No fungus seems responsible. Certain varieties are more susceptible to this disturbance than others."

Similar trouble, known in Illinois under the name of "dry heart", was reported March 1 from Wabash County. The above reports concern themselves with the 1920 crop. Gardner reports an internal brown spot in which small patches of brown corky tissue scattered through the root occur. This was collected at Liberty, Indiana, September 20, 1921.

Drouth injury was reported from Delaware, where it cut the yield from 10 to 30% in some places during August and September. (Adams).

The following state handbooks on sweet potato diseases appeared in 1921:

Manns, T. F. The control of sweet potato diseases. Trans. Penin. Hort. Soc. 34: 77-80. 1921. Some practices that keep down diseases; control of disease and rots in sweet potato storage.

Neal, D. C. Diseases of the sweet potato in Mississippi and their control. Miss. Agr. Exp. Sta. Bul. 190. 16 p. illus. Dec. 1920.

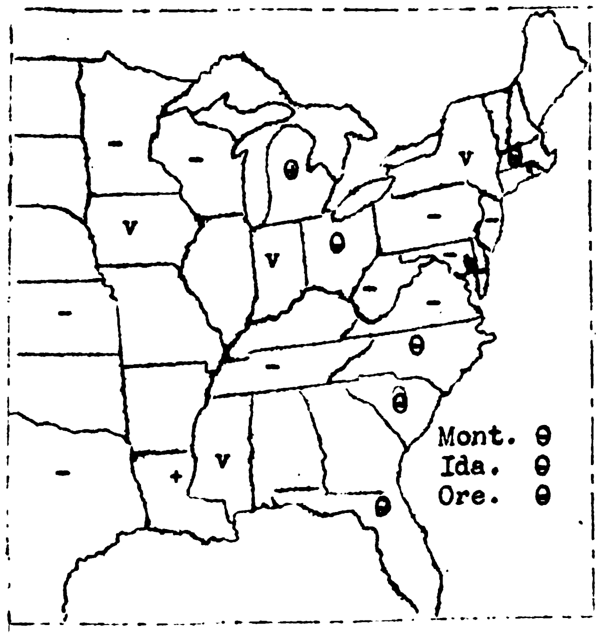
Taubenhaus, J. J. Field diseases of the sweet potato. Sweet potato Bul. v. 2, p. 1-3, 26-27. Dec. 1921.

Cook, M. T. and R. F. Poole. Diseases of sweet potatoes. New Jersey Agr. Exp. Sta. Circ. 123. 24 p. illus. April 1921.

DISEASES OF BEAN

Bacterial blight caused by Bacterium phaseoli EFS

This disease continued in 1921 to be the most serious menace to the bean industry. As shown by the accompanying map (Fig. 80), the disease was prevalent over the entire eastern United States except Vermont and New Hampshire. C. W. Rapp[4] states that in Oklahoma, "The appearance of bacterial blight as a serious disease is dependent upon weather conditions. Warm, wet weather favors its development." The relation to temperature was well borne out in the experience of last season and in the majority of states there was enough rainfall to insure the strong development and spread of the parasite.



θ Very slight
- Slight
v Moderate
+ Important
● Very important

Fig. 80. Distribution and importance of bacterial blight of bean in 1921.

Table 78. Losses from bacterial blight of bean as reported by collaborators, 1921.

Percent loss	State	Percent loss	State
25	Michigan	2-3	Ohio
5-10	Louisiana	2	South Carolina
6	Pennsylvania	1	Maryland, West Virginia, Arkansas, Minnesota, Montana
5	Mississippi		
3-5	New York		
4	Indiana	.5	Georgia, Wisconsin
3	North Carolina, Iowa	t	Idaho, Oregon

Markets inspectors found the disease in shipments of beans from four states, vix., Louisiana, 3 cars with an average of 18% blight spotting; Texas, 2 cars with 9% average; Alabama, 1 car with 50%; and Florida, 1 car with 3%.

Dates of first appearance of bacterial blight of bean, 1921

April 29.	Starkville, Miss.	July 12.....	Marion County, Ind.
July 1...	Ramsey County, Minn.	August 6.....	Doniphan, Kans.
July 1...	Medford, Ore.	August 8.....	Wyoming County, N. Y.
July.....	Monroe County, Ohio	September 20.	Newark, Del.

The following comments from collaborators are of interest:

New York: Kidney types most susceptible of the field beans. (Chupp).

Delaware: On the increase. (Adams).

Virginia: General - especial complaints from Orange, Pulaski, and Montgomery Counties. (Fromme).

West Virginia: Injury mostly to leaves. (Giddings).

Tennessee: (Area near Chattanooga). Common; damage about 5%. (Sherbakoff).

Indiana: Most serious disease of beans. (Gardner).

Michigan: Cut crop short, causing heavy loss in field of high promise. (Coons).

Wisconsin: State wide. (Vaughan).

Minnesota: Found in 75% of fields affecting 75% of the plants. (Section of Plant Pathology).

Iowa: Less than last year. Found in 50% of the fields, affecting approximately half of the plants. (Melhus).

Oregon: Not very important; probably coextensive with host. Kentucky Wonder reported to be almost impossible to mature in Jackson County because of blight. (Barss).

Quebec: Beans were very severely attacked by Pseudomonas phaseoli. (B. T. Dickson[2]).

In a noteworthy contribution, Burkholder[1] shows that bean blight may be a systemic as well as a local disease and this relation must be considered in all control studies. Burkholder also confirms the observation of Muncie[3] as to nodal infection with weakened or necrotic nodes and subsequent breaking over of the vines resulting. This condition was reported in 1921 only from Michigan where considerable damage of this sort was seen, especially with beans in locations exposed to wind sweep.

Varietal resistance and selection of resistant strains is evidently the hope of the future for bean blight control. At present no very good leads exist. Coons reports scarlet and white runner beans as apparently resistant to bean blight but especially subject to hopper-burn. After a close inspection of about 60 seedsmen's varieties, grown in parallel rows, Gardner reports that blight occurred on all, but that the variety "Bird-eye" was not heavily infected. He also reports what apparently was typical blight on the following beans (see mosaic for scientific names): Mung, urd, and hyacinth; while no lesions were noted on moth, rice, adzuki, or kulthi beans similarly exposed to infection.

Rapp[4] reports the disease on Phaseolus vulgaris and on the following: runner varieties (P. multiflorus), the two limas (P. lunatus and P. lunatus macrocarpus), the pinto (a type of P. vulgaris), and occasionally on the black-eyed cowpea (Vigna sinensis).

Literature cited

1. Burkholder, Walter H. The bacterial blight of the bean; a systemic disease. Phytopath 11: 61-69. Febr. 1921.
2. Dickson, B. T. Maladies des plantes en 1920-21. Ann. Rep. Quebec Soc. Prot. Plants 13(1920-21): 66-67. 1921.
3. Muncie, J. H. A girdling of bean stems caused by Bacterium phaseoli. Science n. s. 46: 88-89. July 27, 1917.
4. Rapp, C. W. Bacterial blight of beans. Oklahoma Exp. Sta. Bul. 131: 3-29. 1920.

Anthracnose caused by *Colletotrichum lindemuthianum* (Sacc. & Magn.) Br. & Cav.

Anthracnose was generally less important in 1921 than it was in 1920. Reported then as causing the most serious loss for years in New York, it presents in 1921 the interesting result of still causing a considerable loss in that state in spite of weather unfavorable for its spread. This condition was due doubtless to the heavy seed infestation.

Table 79. Relative prevalence of and estimated losses from bean anthracnose, as reported by collaborators, 1921.

State	Amount compared with 1920	Amount compared with Average year	Percentage loss
New Hampshire	- -	Less	-
Vermont	Less	Less	1-3
New York	Less	Less	3-5
New Jersey	Less	Less	2
Pennsylvania	About same	About same	5
Maryland	Less	Less	1
Virginia	- -	About same	-
West Virginia	Less	Same	2
Mississippi	Less	Less	2
Louisiana	About same	About same	2-5
Texas	- -	- -	1
Arkansas	- -	- -	1
Ohio	Less	Less	5
Illinois	Same	Same	t
Wisconsin	Less	Less	t
Minnesota	Less	Less	0
North Dakota	Same	Same	-
Iowa	Less	Less	.5
Kansas	- -	- -	t
Oregon	- -	- -	t

Anthracnose spotting occurred on string beans in 10 of the 108 cars inspected by the Bureau of Markets and Crop Estimates, from the following states: South Carolina, 4 cars with an average of 3% anthracnose; Mississippi, 2 cars with 6%; Louisiana, 2 cars with 14%; and Texas, 2 cars with 2%.

Dates of first appearance of bean anthracnose, 1921

May 6.... Wiggins, Miss.
June 17.. Portsmouth, N. H.
July 1... Medford, Ore.
July ..... Rocky Ford, Colo.
August 1.. Madison, Wis.
August.... Wayne County, Ohio.

For comments of collaborators see Pl. Dis. Bul. 5: 34, 50, 68, 85, 101. 1921.

Breeding for disease resistance carried on in many experiment stations promises successful results. Investigational work reported from the Cornell Agricultural Experiment Station[1,2] and from the Michigan Agricultural College indicates progress.

Recent literature

Cited

1. McRostie, G. P. Inheritance of disease resistance in the common bean. Jour. Amer. Soc. Agron. 13: 15-32. Jan. 1921.
2. Reddick, D. A hybrid bean resistant to anthracnose and to mosaic. (Abstract) Phytopath. 12: 47. Jan. 1922.

Not cited

Barrus, M. F. Bean anthracnose. New York (Cornell) Agr. Exp. Sta. Memoir 42: 101-215. Fig. 10-20. Pl. 1-8. July 1921.

Rust caused by Uromyces appendiculatus (Pers.) Lev.

Rust, causing a spotting of the leaves and sometimes the pods, was reported from New York, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Tennessee, North Carolina, South Carolina, Florida, Mississippi, Louisiana, Ohio, Indiana, Michigan, Wisconsin, Minnesota, Colorado, Oregon, California, and the Philippine Islands[2]. The following states report definitely that the disease was not observed: Vermont, New Hampshire, Arkansas, and Iowa.

Table 80. Losses from rust of bean, as reported by collaborators, 1921.

Amount of loss	State
Slight (trace or negligible)	Massachusetts, New York, Pennsylvania, Maryland, West Virginia, Tennessee, North Carolina, Ohio, Michigan, Wisconsin, Minnesota, Colorado, and Oregon
1%	South Carolina, Mississippi
2%	California

Dates of first appearance of bean rust, 1921

May........ Jackson, Miss.
July 1..... Medford, Jackson Co., Ore.
August 3... Greenwood, S. C.
August 20.. East Lansing, Mich.
August..... Wayne County, Ohio
August ...... Rocky Ford, Colo.
September 1.. California
September 1.. Madison, Wis.
September 6.. Onondaga Co., N.Y.
September 30. Wyoming, Del.

Interesting notes concerning varietal susceptibility are available from several observers. In this connection the lists of Fromme and Wingard[1] should be considered. Many collaborators report the Kentucky Wonder as leading in susceptibility as will be seen from the following quotations:

<u>New York</u>: Mostly on pole beans or coming late on a few field beans. Onondaga County: Severe on Kentucky Wonder pole beans. (Chupp).

<u>Delaware</u>: On white shell beans. (Adams).

<u>West Virginia</u>: Pole beans affected mostly. Quite common on Kentucky Wonder. (Giddings).

<u>Tennessee</u>: Bean rust was common, more damaging to pole varieties. (Sherbakoff).

<u>South Carolina</u>: White Kentucky Wonder is susceptible to some extent. (Ludwig).

<u>Florida</u>: Some rust on Kentucky Wonder. (Burger).

<u>Louisiana</u>: In general the bush beans (snaps) are resistant. The one with which we have the most difficulty is the Kentucky Wonder. This variety is frequently killed by the rust. (Edgerton).

<u>Indiana</u>: The following report of the results of experiments conducted by E. B. Mains at Purdue University was received through Gardner:

The varietal susceptibility of beans in the rust experimental plot at Lafayette in 1921 was as follows:

<u>Not affected</u>. Pencil Pod Wax, Hodson Wax, Wardwell's Kidney Wax, Red Kidney, Saddle Back Wax, Rust Proof Golden Wax, Mohawk, Golden Eye Wax, Stringless Refugee, Valentine Wax, Black Valentine, Dwarf Horticultural, Bird's Eye, Mexican Red, Currie Rust Proof Black Wax, Improved Goddard, Yellow Eye, Masterpiece Dwarf, New Pearl, Webber Wax, California Rust Proof, Detroit Wax, Hodson Green Pod, May Queen, Trucker's Reward, Refugee (1000-1) Horticultural Pole, Wren Egg, Marblehead Pole, Home Sweet Home.

The following beans belonging to other species (see mosaic for scientific names) were not infected: Hyacinth, adzuki, urd, kulthi, rice, mung, and moth.

<u>Slightly infected</u>: Michigan White Wax, Full Measure, Bountiful Stringless, Early Red Valentine, Currie Golden Wax, Keeney's Stringless Refugee, Green Seeded Flagolet, Improved Golden Wax, Dwarf Horticultural, White Kidney, French Horticultural.

<u>More or less heavily rusted</u>: Black Turtle Soup, Robust Pea, New McCaslan, Pinto, Lady Washington, Boston Navy, Snowflake, White Creaseback, Burger Green Pod, McCaslan Pole, Golden Cluster, White Dutch Caseknife, Powell's Prolific, White Kentucky Wonder, Tennessee Green Pod, Kentucky Wonder Wax, Kentucky Wonder.

<u>California</u>: Among varieties found affected were Black Eye, Lady Washington, French White, Red Valentine, and Pink. (Milbrath, July 1).

Black Eye, Pink, Yellow Eye, Valentine particularly susceptible. (Milbrath, final report).

<u>Philippine Islands</u> (Trinidad, Mountain Province, December): This rust is very serious at the present time and according to Mr. Wright (Supt. of the Trinidad Farm School) becomes widespread, attacking

all varieties with one exception...... a red variety of P. vulgaris. (Colin G. Welles[2]).

Literature cited

1. Frome, F. D. and S. A. Wingard. Varietal susceptibility of beans to rust. Jour. Agr. Res, 21: 385-404. June 15, 1921.
2. Welles, Colin G. Plant diseases found at Trinidad, December 1921. Philipp. Agr. 10: 348-349. Febr. 1922.

Mosaic (cause unknown)

Mosaic was reported from the extreme eastern and western parts of the United States and from Quebec[1] to Louisiana. Being seed-borne it may be expected to have a range practically coextensive with the crop, although as evidenced by reports from some collaborators it was not seen or was masked by weather effects last season in some regions.

The importance of the disease in 1921 is indicated in Table 81.

Table 81. Estimated losses from bean mosaic, 1921.

Amount of loss	States reporting
Not observed	Vermont, New Hampshire, West Virginia, South Carolina, Texas, Ohio
Slight	Massachusetts, Connecticut, North Carolina, Washington
Considerable	Mississippi
Severe	California
t	Michigan, Wisconsin, Kansas
1%	Louisiana, Minnesota, Montana
2%	Georgia, Arkansas, Indiana, Iowa
2-3%	Pennsylvania
2-5%	New York
5%	Oregon
10%	Idaho

Collaborators comment as follows (see also Pl. Dis. Bul. 5: 34, 50, 68, 86, 102, 1921).

Connecticut: One report; July 7 At Whitneyville, where the disease was found on Hodson Wax (50%) and on Old Homestead (10%). (Clinton).

New York: Probably same as last year; less important than several seasons ago. There has been a continued reduction in acreage of susceptible varieties. (Chupp).

Since most of the pea beans grown are the Michigan Robust, the mosaic was not a serious factor on the dry shelled beans. (Burkholder, Jan. 24, 1922).

Mississippi: Unimportant; occurring locally. First seen May 5 at Poplarville and Utica; caused greatest damage to plants two-thirds mature between April 25 and May 15. (Neal).

Louisiana: About same as usual and as last year; very common. (Edgerton).

Indiana: Noted in many gardens. About 10% of plants affected. (Gardner).

Michigan: Occasional. Evidence of field spread by insects secured by Nelson. (Coons).

Minnesota: First reported on University Farm, June 10. Infection light. Later complicated by the effects of hot weather and hopper burn. The usual symptoms of mosaic were difficult to determine in various fields about University Farm. (September 15). General, of considerable importance; found in 90% of the fields, which showed an average of 5% affected plants. (Section of Plant Pathology).

Montana: Comparatively few beans grown on commercial scale this year. A small amount of mosaic was seen. (Jennison).

Idaho: Less than last year, but still very important. (Hungerford).

Oregon: Same as usual, serious. Coextensive with host and severe in many cases. (Barss).

California: Same as last year, severe in some localities - at Puente in Los Angeles County, and in the San Joaquin Valley. (Milbrath).

Robust bean continues in favor in many localities and large acreages for seed purposes are being grown in Michigan, New York, and Canada. Close inspection of improved strains at Michigan showed resistance to mosaic to be extremely high, whole increase plats failing to show more than an occasional individual with mosaic. Common stock, on the contrary, showed considerable mosaic. (Coons). Promising results from the point of view of both mosaic and anthracnose resistance are to be expected from the hybrids between the Robust bean and the various anthracnose resistant kinds which have been developed at several stations, and are being carefully tested to determine their commercial value.

A report from Gardner (Indiana) on observations of 60 seedsmen's varieties of beans grown in plats with short rows, shows that mosaic occurred on 37 varieties. The following varieties were free from mosaic: Wardwell's Kidney Wax, Red Kidney, Saddleback Wax, Dwarf Horticultural, Robust Pea, Black Valentine, Improved Goddard, and Webber Wax.

Of species other than *P. vulgaris*, Gardner reports that mosaic occurred upon: adzuki bean (*Phaseolus angularis* (Willd.) W. F. Wight; urd bean (*P. mungo* L.); mung bean (*P. aureus* Roxb.): but not upon: kulthi bean (*Dolichos biflorus* L.); rice bean (*P. calcaratus* Roxb.); moth bean (*P. aconitifolius* Jacq.); and hyacinth bean (*Dolichos lablab* L.); although all were similarly exposed to infection. Mosaic occurred also on lima bean (bush variety).

Recent literature

Cited

1. Dickson, B. T. Maladies des plantes en 1920-21. Ann. Rept. Quebec Soc. Prot. Plants 13: 66-67. (1921).

Not cited

Barss, H. P. Bean blight and bean mosaic. Oregon Agr. Exp. Sta. Crop Pest and Hort. Rept. 3: 192-196. Fig. 56-59. 1921. (Abstr. by E. J. Kraus in Bot. Absts. 9: Entry 918. September 1921).

Root rot caused by _Fusarium_ spp.

Root rot definitely attributed to _Fusarium_ spp, was reported from Massachusetts, New York, West Virginia, Tennessee, Indiana, and California. Doubtless many of the reports from other states under the general name of stem end and root rots are also assignable to this cause. Losses in general were slight, probably not amounting in any case to more than 2%. The following comments from collaborators give the facts at hand (see also Pl. Dis. Bul. 5: 35, 86, 102. 1921).

General: As to the extent of the Fusarium root rot of the beans, I have only received it from two other states besides New York; that is, Michigan and Vermont. This last summer, however, I received specimens of beans having a root rot from Indiana and Washington, D. C. In both cases it appeared to be Fusarium root rot, but as I did not make any isolations, I would not like to make a definite statement. (Burkholder, Jan. 24, 1922).

Massachusetts: Stem rot caused by Fusarium and Rhizoctonia very severe in a few instances. (Osmun).

New York: _Fusarium martii phaseoli_ fairly general, causing a loss to the state of 1-2%; especially in the dry bean sections and in the gardens in other sections. First found July 7 at Warsaw. General distribution for the state is western. (Chupp).

West Virginia: Local. A few cases severe. (Giddings).

Tennessee: Root rot (Probably Fusarium) in some fields not uncommon. Damage to that section of the state (Chattanooga) probably about 2%. (Sherbakoff).

Indiana: Less prevalent than last year and of minor importance. Found by R. C. Friesner very severe on Kentucky Wonder and not occurring at all on Bountiful Bush, Early Leviathian Lima, and German Black Wax. First seen July 14 in Marion County. (Gardner).

California: Stem rot caused by Fusarium and Rhizoctonia worse than last year. Destroyed 75% of crop in some fields; caused an average reduction of 5% of the crop of dry beans. Limas and Red Mexican suffered most. (Milbrath).

Rhizoctonia rot caused by _Corticium vagum_ Berk. and Curtis

Rhizoctonia, common as a soil parasite, is doubtless strongly affected by particular spring conditions. In the reports for 1920, root and stem rots

of bean due to this fungus were reported as very common in New Jersey and various other states, but in 1921 this disease was of very minor importance in the United States as a whole. It was reported by Thurston as severe in Lebanon County, Pennsylvania. It was found in North Carolina; and was as usual serious on the fall crop in Louisiana. The disease occurred also in Texas, Idaho, and Washington, according to collaborators, and in Massachusetts and California, where it was associated with *Fusarium* sp. (See Fusarium).

Stem rot and watery soft rot caused by *Sclerotinia libertiana* Fckl.

This disease was reported in 1921 as less important than last year and doing only slight damage in the field. It occurred locally in New York and West Virginia. On the other hand this organism is of prime importance in causing a rot of the snap beans in transit as is shown by an examination of markets inspectors reports.

Stem rot (cause undetermined)

An unnamed stem rot caused considerable damage in a field at St. Albans, Vermont. Ludwig reports mung beans (*Phaseolus aureus*) severely affected with an undetermined stem rot in Chester County, South Carolina. In the Far West Barss reports that stem rot was not serious except perhaps locally in the hotter sections of eastern and southern Oregon.

In this disease complex careful work, backed by intensive study of specimens and of soil infestation, and by free interchange of material between workers seems very desirable.

Other diseases

The organism causing a new bacterial wilt of bean has been described by Miss Florence Hedges of the Laboratory of Plant Pathology, Bureau of Plant Industry, as *Bacterium flaccumfaciens* (A bacterial wilt of the bean caused by *Bacterium flaccumfaciens* nov. sp. Science n. s. 55: 433-434. April 21, 1922). The disease appeared on navy beans in South Dakota in 1920 and 1921. Miss Hedges has infected King of the Mountain and Great Northern beans, King of the Garden lima, and Ito San soy-beans by pure culture inoculations. The following quotation is from her article:

> "A new bacterial disease of navy beans has appeared in South Dakota. The grower on whose farm the disease was discovered reports that what he believes to be the same disease killed 90% of his 1920 crop. In 1921 he planted the seed harvested from the remainder and lost about 25% of his crop. Some of this 1920 Dakota seed planted at Arlington, Virginia, also produced a large proportion of diseased plants, many of which never survived the seedling stage. The disease is characterized by a wilting of the leaves of seedlings, sometimes accompanied by a discoloration, and by dwarfing, reduction of yield and the death of some of the shoots, if the plant survives the early stages of growth."

Angular leaf spot due to *Isariopsis griseola* Sacc. was reported from West Virginia and for the first time to the Survey from Pennsylvania and

Delaware. In West Virginia it was more important than last year, being severe in a few instances according to Giddings. Thurston and Orton report it as present in gardens in Center County, Pennsylvania. Adams reported it as first noticed on September 20 at Newark, Delaware on kidney beans. Browning reports the disease as occurring in Rhode Island in 1920, when it was very abundant and destructive to the foliage and pods, although previously it had been of only minor importance.

Leaf spot caused by *Cercospora canescens* Ell. & Mart. was reported by Taubenhaus as unimportant in Texas.

Powdery mildew caused by *Erysiphe polygoni* DC. was reported as unimportant in Texas, and as serious in California where it caused 6% loss in San Diego, Riverside, Los Angeles, and Orange Counties, according to Milbrath.

A leaf blight of husk beans, apparently caused by Rhizoctonia, was found by Sherbakoff in the vicinity of Chattanooga, Tennessee, August 11.

Rhizopus rot caused by *Rhizopus* sp., typically a disease of beans under transit conditions, may cause serious loss.

A seed spot of unknown cause affecting both the surface and interior of the bean is reported by Milbrath as severe throughout southern California, causing a reduction of 30% in the yield of the variety Black Eye, to which it was confined.

Texas root rot caused by *Ozonium omnivorum* Shear was reported, as usual from Texas.

Root knot (*Heterodera radicicola*) Greef. Müll.) was reported by Ludwig as present in the northwestern part of South Carolina, and from Texas as unimportant. On the other hand, Elliott (July 1) reports that several severe outbreaks in Arkansas were brought to his attention.

Sunscald was reported from Wisconsin and Michigan as causing some defoliation.

Chlorosis, said to be caused by land too rich in lime, was reported by Taubenhaus from Texas.

DISEASES OF LIMA BEAN

Downy mildew caused by *Phytophthora phaseoli* Thax.

In 1920 downy mildew was reported as widespread and more destructive than usual in the northeast, occurring in seven states. In 1921, on the other hand, it was reported only from Connecticut, New York, and Delaware. The crop was injured to considerable extent in some places in Connecticut, according to Clinton. The disease was less prevalent than usual in Delaware, doubtless due to its late appearance (earliest record September 1, at Newark - Adams). It was especially severe in Suffolk County, New York as shown by the following report:

> New York: Lima beans grown to any extent only on Long Island. Mildew reported only from Suffolk County; reduction in yield 5%. Mr. I. H. Vogel states, "In Suffolk County in the fore part of the season the loss was rather heavy (15-20%). Weather conditions checked it later." (Chupp).

Bacterial blights caused by Bacterium spp.

Bacterial blights of lima bean were reported from Pennsylvania, West Virginia, and Indiana during 1921.

Pennsylvania: Dr. Beach has reported from Bustleton a bacterial blight of pole lima beans that is causing a 5-10% loss. The disease causes a premature ripening and drying of the pods. He has observed it for four seasons but states that it has caused real loss for the first time this year. It appears to be general in the vicinity of Bustleton. (Thurston, August 15).

West Virginia: Specimen collected at Hinton, August 5 by R. J. Haskell. Determined in the Pathological Laboratory of the Federal Department of Agriculture as being Bacterium phaseoli.

Indiana: Bacterial blight (Bacterium phaseoli ? - may be more than one species involved) serious seed stain in canning crop. Causes spotting of leaves, pods, and seeds. First observed July 12 on pole beans in Marion County. Yellow organism isolated from pole varieties in gardens but not from canning crop disease. Our 1920 report of Phyllosticta phaseolina more than likely incorrect and should be one of these bacterial spots. (Gardner).

Other diseases

Leaf spot and pod blight caused by Diaporthe phaseolorum (C. & E.) Sacc. was reported from New York (rather severe in Suffolk County, 5-10% loss; dry midsummer), New Jersey (less severe; dry weather), and West Virginia (local; one rather severe case observed). The leaf spot reported from Indiana in 1920 under Diaporthe phaseolorum (Pl. Dis. Bul. Suppl. 16: 234-235. June 1, 1921 - reported by Gardner as Phyllosticta phaseolina Sacc.) was probably a bacterial spot instead, according to Gardner (see report quoted under bacterial blights).

Powdery mildew (only conidial stage present) - noted only in greenhouse in Indiana; reddish brown blotches under the mycelium. (Gardner).

Mosaic (cause undetermined) was reported on lima beans in Indiana (bush variety), and Missouri.

Stem rot caused by Fusarium sp. and Rhizoctonia sp. was severe on lima beans in California according to Milbrath (see quotation under Fusarium stem rot, common bean).

Lightning injury traceable to lightning striking the ground June 11 was reported by Clinton from Northford, Connecticut on June 18.

A parasitic yeast (Nematospora sp.) which causes a seed spot of lima beans resembling bacterial spot was reported by Wingard from eastern Virginia. (Wingard, S. A. A yeast parasitic on lima beans. (Abstract) Phytopath. 12: 47. Jan. 1922.

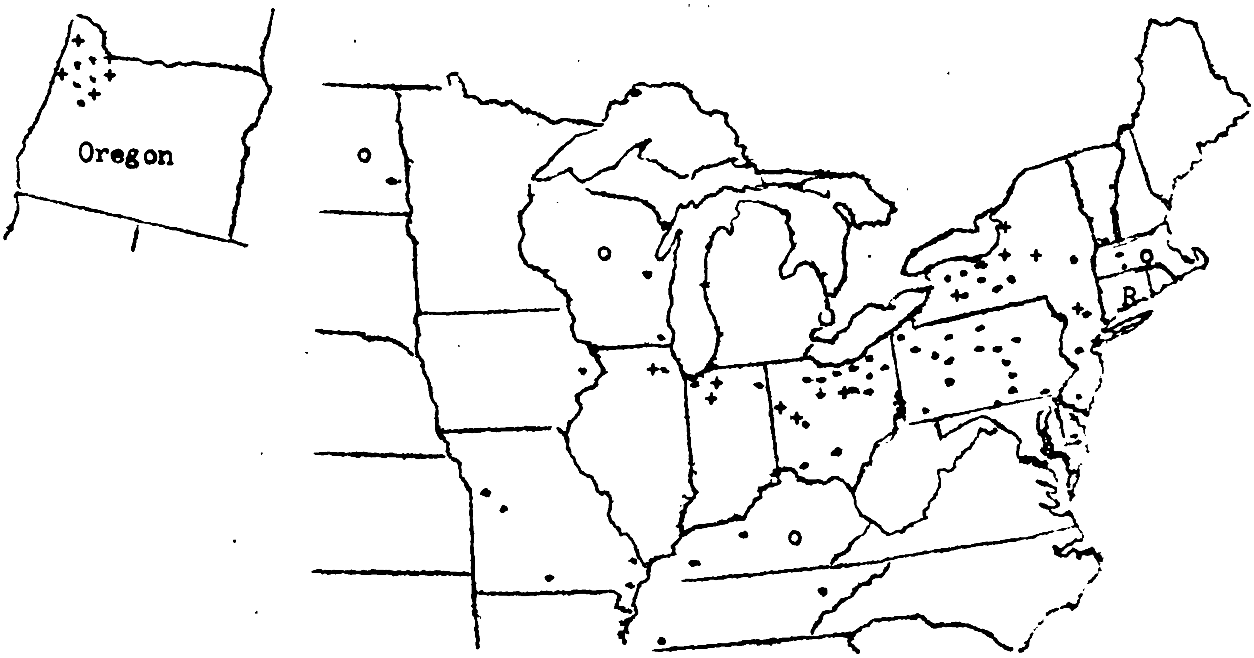
Seed stain, caused probably by Fusarium sp. was reported from Indiana: "Of considerable importance in the canning crop in Johnson County; causes brown discoloration of seed coat which renders beans worthless for canning. First reported September 10 at Greenwood. Occurs in older pods that have turned brown; probably in those in contact with soil." (Gardner).

Moldy pods, cause unknown, - reported from Kentucky: "Pole lima beans making rapid growth affected during moist weather .(Valleau).

DISEASES OF ONION

Smut caused by Urocystis cepulae Frost

The distribution of onion smut as it has been reported to the Survey is indicated on the accompanying map (Fig. 81). The following states definitely report the disease as never having been reported: Louisiana, Texas, Colorado, Michigan, and Minnesota.



. Reports prior to 1921 (counties)
R Reports prior to 1921, localities not given
+ 1921 reports (counties)
o 1921 reports, localities not given

Fig. 81. Distribution of onion smut, as reported to the Plant Disease Survey, 1903-1921.

Dates of first appearance of onion smut, 1921

April............... Beaverton, Oregon
May 23.............. Orange County, New York
June 16............. Jasper County, Indiana

In areas where extensive infestation occurs onion smut was evidently far more serious in 1921 than in previous years. Data concerning losses due to smut and prevalence of the disease are summarized in Table 82.

Table 82. Relative prevalence of and estimated losses from onion smut in 1921, as reported by collaborators.

State	Importance	Prevalence compared with 1920	Prevalence compared with Average year	Percent loss
Massachusetts	--	--	Same	--
New York	Very	More	--	20
Kentucky	Very (in sets)	Worse	Worse	15
Ohio	Moderate	Same	Same	--
Indiana	Only in sets	--	--	--
Illinois	Not very	Same	Same	--
Wisconsin	High in infected soil	More	More	--
North Dakota	Not very	Same	Less	--
Oregon	Worst disease	Worse	Worse	1

A number of states report excellent results from formaldehyde drip treatment:

Massachusetts: About the usual amount. The general use of formaldehyde gives good control on most fields. (Osmun).

New York: In Orange County preliminary counts showed 15-20% in fields not treated and 5% in treated fields. A later report showed 52% in checks. In Madison County treated rows had double the yield as compared with the check. (Chupp).

Ohio: Excellent control wherever formaldehyde drench treatment is used. (Thomas).

Indiana: C. T. Gregory reports good control in Lake County with formalin drip on seed drill. (Gardner).

Illinois and Wisconsin: Formaldehyde drip control was used more generally than ever before in the Racine, Wisconsin and Cook County, Illinois districts this season with success. (Walker).

Wisconsin: It was so cold and wet immediately after onions were planted that seed did not germinate for some time and the value of treatment was largely lost. (Vaughan).

Oregon: The two important problems in the onion growing section of Washington County are the smut and mildew. Professor Barss has a small but very convincing demonstration of formaldehyde drip control for smut in one field. He has tried out several formulae and the results coincide with those we have secured in eastern sections. (Walker, News Notes, Office of Cotton, Truck, and Forage Crop Disease Investigations, August 6, 1921, page 4).

Formaldehyde drip treatment in seeding controls very successfully. (Barss).

The following new literature has appeared, the contribution by Walker and Jones being especially pertinent in giving an explanation of the range of this disease.

Walker, J. C. and Jones L. R. Relation of soil temperature and other factors to onion smut infection. Jour. Agr. Res. 22: 235-261. Pl. 25-27. Oct. 20, 1921.

Whitehead, T. On the life history and morphology of Urocystis cepulae. Trans. Brit. Mycol. Soc. 7: 65-71. Pl. ii. July 1921.

Whitehead, T. Experiments on the control of onion smut. Jour. Min. Agr. Gt. Brit. 28: 443-450. August 1921.

Downy mildew caused by Peronospora schleideni Ung.

Downy mildew is known from the records of the Survey to occur from coast to coast. In 1920 the disease was reported from eastern, southern, and western United States. The records for 1921 parallel those of the former year. The following observations were made by collaborators (See also Pl. Dis. Bul. 5: 118. Oct. 1, 1921):

Louisiana: Very common this season on onions and shallots; doing considerable damage. (Edgerton).

Ohio: Less damage than last year, of moderate importance. First appearance late in June. (Thomas).

Oregon: Unimportant; loss a trace. General in northern Willamette Valley onion sections; also found in Coos County, July 14. Cool, moist, prolonged spring. Disease started rather actively in the spring but disappeared due to hot dry summer weather continued through harvest. (Barss).

California: About as prevalent as last year, causing 2% reduction in yield for the state. Found on seed stock in Santa Clara County. (Milbrath).

The following states report absence of downy mildew: New Jersey, Massachusetts, Texas, Wisconsin, Michigan, Minnesota, Colorado, and Washington.

Recent literature

Murphy, P. A. The presence of perennial mycelium in Peronospora schleideni Unger. Nature 108: 304. Nov. 3, 1921. No. 2714.

Various troubles caused by Botrytis spp.

Onion rots attributable to Botrytis spp. taking various forms, "neck rot", "bulb rot", "failure of sets", "blasting of seed heads", have been reported to the Plant Disease Survey and in the literature from many localities in previous years. There is evidently a complex of disease conditions, the etiology of which is not at all clear at present. In New York and Michigan the results of studies by Munn have shown definitely that Botrytis allii Munn is capable of producing all of the troubles mentioned above. With onions in transit other species of Botrytis, presumably of the cinerea type, seem to be another factor in loss production. From the data at hand, it is

not possible to state the pathogene concerned. The following statements are quoted to show the importance of diseases of this type with a view to focusing attention upon this field for study.

Indiana: Neck rot caused by Botrytis sp., doing considerable damage in Fulton County, also occurred in Kosciusko and Steuben Counties. The rot was not necessarily at the neck, but may be anywhere on the bulb. First seen with ~~1920 crop, March 9, with~~ 1921 crop, August 18. (Gardner).

Wisconsin, Illinois, and Kentucky: Very little neck rot noted in the Racine, Chicago, and Louisville sections. (J. C. Walker).

Wisconsin: Neck rot caused by Botrytis allii less, of minor importance; too hot. (Vaughan).

Idaho: Neck rot caused by Botrytis sp., unimportant. Reported from one or two isolated portions of the state. (J. M. Raeder).

Washington: Neck rot, Botrytis allii, in Walla Walla and Whitman Counties. (Dana).

Oregon: Bulb rot - Botrytis sp. Little known (only one record, Ashwood, Jefferson County, March 1) about the range or extent of severity. (Barss).

Reports by market inspectors separate losses into two types; neck rot and gray mold rot, but as inspection of tables show, these conditions vary and other molds are also concerned in the decay.

Table 83. Losses from gray mold rot of onions caused by Botrytis sp. as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: Number of cars	Percent
California	12	8	9	5-25
			3	2
Indiana	1	6	1	6*
Iowa	4	3	4	2-8
Texas	17	6	3	15-25
			14	2-7
Washington	1	13	1	13
Spain	1	20	1	20
Unknown	8	6	8	2-12

Total number of cars with gray mold rot............ 44
Total number of cars of onions inspected...........837

*Associated with slimy soft rot.

Table 84. Losses from neck rot of onions caused by Botrytis sp. as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay	
			Number of cars	Percent
California	1	8	1	8*
Illinois	1	5	1	5**
Indiana	5	3	5	2-6
Kentucky	2	6	2	2-10*
Massachusetts	3	8	3	3-14*
Michigan	3	13	1	33 F
			2	2-5*
New York	22	11	11	10-33*
			11	2-9*
Ohio	5	3	5	2-8*
Oregon	8	4	8	2-8
Texas	4	32	3	27-65#
			1	3
Washington	2	10	2	8-12
Wisconsin	1	4	1	4*
Spain	6	15	4	17-25#
			2	5-6
Unknown	3	28	1	55*
			2	13-15

Total number of cars with neck rot............. 66
Total number of cars of onions inspected....... 887

*Associated with slimy soft rot ** Advanced decay
#Associated with other decays F Following freezing injury

Pink root caused by Fusarium malli Taub.

Onion pink root, known in the records of the Plant Disease Survey to occur in New York, Indiana, California, Texas, and Louisiana, was reported in 1921 from Texas, Oregon, and California. In Texas the loss was estimated at 5%. In Oregon, although it is not uncommon in the northern Willamette Valley, it is not serious anywhere, and caused only a slight loss, according to Barss. The most serious loss was reported from California by Milbrath. The total yield of the state was reduced 14% due to root decay of small onions in the Delta region where a thousand acres were almost a total loss. The disease occurred in the Coachella Valley region also.

Other diseases

Macrosporium parasiticum Thüm. was reported from Wisconsin and Louisiana (black molds, rotting of seed stalks), Studies at the University of Wisconsin by N. G. Teodoro (Pathogenicity of Macrosporium parasiticum. (Abstract) Phytopath. 12: 50. Jan. 1922) indicate that this organism, formerly

considered a secondary parasite invading downy mildew lesions, may produce distinct lesions on leaf and seed stems, often girdling the latter. Comparative studies are in progress with other Macrosporia from onion. Edgerton had previously called attention to the probability of this condition in Louisiana Station Bulletin 182: page 10.

Walker reports Macrosporium rot in two lots of white onion sets found at Louisville, Kentucky, January 1922. Black mold caused by Macrosporium sp. was reported from Kansas.

Smudge caused by Colletotrichum circinans (Berk.) Voglino was reported as of minor importance from Indiana where it occurred on bulbs in storage and from Wisconsin on both seedlings and bulbs. In the latter state it was not found on the red onion which is largely grown for commerce. For a discussion of the resistance of different types see: Walker, J. C. Onion smudge. Jour. Agr. Res. 20: 685-722. Febr. 1, 1921.

Soft rot caused by bacteria of the Bacillus carotovorus group was reported from South Carolina, Ohio, and Indiana, occurring occasionally and doing some damage as a storage rot. In Kentucky the loss was considered very important in shipments from Louisville.

Bulb rot caused by Fusarium sp. was reported from Indiana (Bureau of Markets certificate; Steuben County 1921 crop; August 18 - Gardner); and a Fusarium rot was reported from Payette, Idaho by J. M. Raeder.

Black mold caused by Aspergillus niger Van Tieghem (Sterigmatocystis) was reported as unimportant from Texas (Webb County) and Indiana (Fulton County), but found to be doing considerable damage in California as a storage rot, where its reduction in yield was placed at 4% of the state yield. (Milbrath).

This mold is important in causing blemish and decay of onions in transit and storage.

Blue mold rot, Penicillium sp., while in general of minor importance in field and storage as compared with molds of the Botrytis type, was of considerable importance under transportation conditions, especially in long distance shipments.

Tip-burn was reported from Massachusetts. "The onion crop in Massachusetts is only about 30% of normal. The reduced yield is due largely to drouth conditions which favored tip-burn and prevented full development of the bulbs." (Osmun, September 15).

DISEASES OF CRUCIFERS

CABBAGE

Club root caused by Plasmodiophora brassicae Wor.

This disease is distributed throughout the United States with the exception of the western plain and mountain regions, and in 1921 was reported as doing about the same amount of damage as before. Its occurrence is occasional and serious loss occurs only locally, hence, in general, its effect on the yield is negligible. The maximum amount found in any field in Vermont was 10%, with a state reduction in yield estimated by Lutman at 1-3%.

Browning reports cauliflower to be more seriously affected than cabbage in Rhode Island. Chupp estimates that the reduction in yield for New York is between 1 and 3%. Cook of New Jersey states that the disease was severe in some cases, the loss being 1.5%. Giddings in West Virginia estimates the loss as a trace. Barre of South Carolina reports only a single case; and reports from Louisiana, Texas, and Arkansas indicate that the disease is not present in those areas. Gardner reports the disease as unimportant and known only in Lake and Elkhart Counties, Indiana. Vaughan reports the disease of minor importance in Wisconsin. In Minnesota the disease is reported as about the same prevalence as before, but not general enough to be serious, affecting 5% of the fields in the state, and estimating the loss as a trace. Melhus reports the disease as serious at Amana, Iowa. Bolley of North Dakota reports it for 1920 but not for 1921. South Dakota, Kansas, Montana, Colorado, and Washington have negative reports.

No new American investigations are reported on this disease, but work which would give more definite suggestions as to quantity of lime to be recommended on different soil types and proper soil reaction to attain would be valuable.

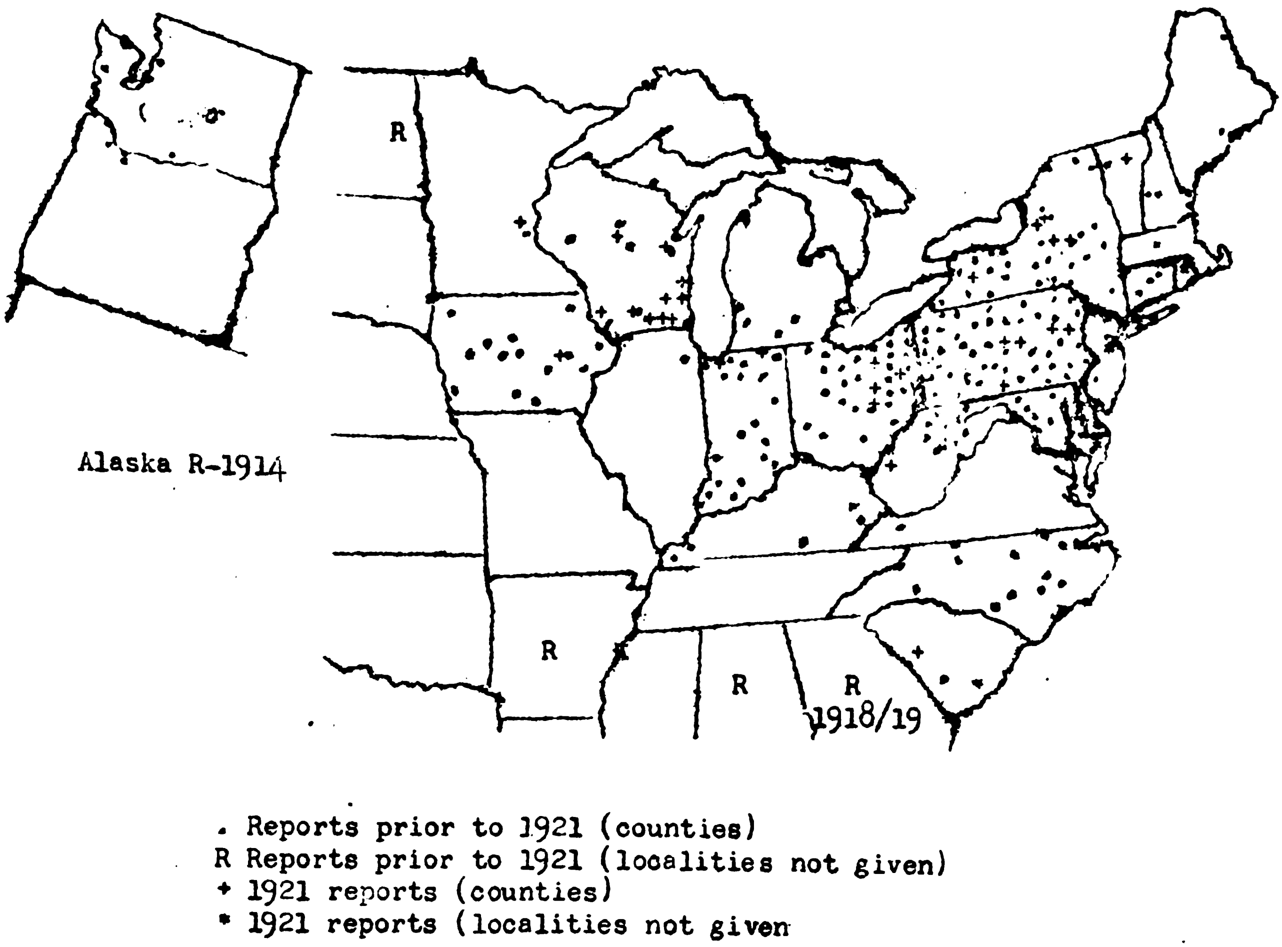


Fig. 82. Distribution of cabbage club root as reported to the Plant Disease Survey, 1903-1921.

Yellows caused by *Fusarium conglutinans* Woll.

Cabbage yellows again ranked as the most important cabbage disease, taking on this year its most serious aspect. A few new infested localities appeared in certain states and there was marked extension of certain other areas. The losses by states are indicated in Table 85.

Table 85. Prevalence of and estimated losses from cabbage yellows, as reported by collaborators, 1921.

State	Estimated loss	Remarks
Vermont	0	Not observed
Rhode Island	0	Not observed
Connecticut	0	Not yet reported from this state
New Jersey	t	One record
Pennsylvania	5%	Becoming more important
Delaware	t	
Maryland	8%	Worst cabbage disease, general over eastern half of state; increasing
Virginia	15%	Worst cabbage disease; prevalent in southwest
West Virginia	t	Locally severe
Kentucky	5%	Less prevalent
Tennessee	t	Serious in some instances
South Carolina	t	Single instance noticed
Louisiana	t	No serious complaints
Texas	20%	Very prevalent
Arkansas	15%	General, serious
Ohio	5%	General, serious
Indiana	4%	Severe in early crop only
Illinois	5%	More prevalent, very important in cabbage growing localities
Michigan	t	Increasing
Wisconsin	9%	More
Minnesota	1%	Locally very important
Iowa	25%	Very serious factor
Kansas	30%	Caused great loss
Montana	.5%	General, not important
Colorado	-	No reports
Washington	-	No reports

Dates of first appearance of cabbage yellows, 1921

May 23.................... Wyandotte County, Kansas
June 1.................... Lake County, Indiana
June...................... Washington County, Ohio
June...................... Marion, Virginia
July 3.................... Racine, Wisconsin
September 16.............. Ramsey County, Minnesota
October 25................ Guyencourt, Delaware

The following comments from collaborators are of interest (see also Pl. Dis. Bul. 5: 35, 68, 135. 1921).

Pennsylvania: Cabbage yellows was more serious than usual as a result of the high temperatures over a long period in some sections, notably eastern. (Thurston).

Virginia: Most destructive cabbage disease; 15% reduction in yield. Prevalent in commercial fields in the southwest, which produces one-half the tonnage of the state; 25-30% loss in this section. Wisconsin Hollander and Wisconsin All Seasons very resistant; commercial varieties All Head Early and Copenhagen Market very susceptible. (Fromme).

Kentucky: Very important, when present crop was a complete failure. High temperatures and small rainfall probably influenced severity where present. Less prevalent this year because growers whose fields have shown yellows have stopped planting since they have heard cause of disease. (Valleau).

Ohio: In late cabbage sections industry being reclaimed by the resistant varieties. Early cabbage sections showing greater losses each year. (Thomas).

Indiana: Heat and drouth of June and July made yellows very destructive. Rains late in summer and cooler temperatures checked the disease. Wisconsin Hollander being used in Lake County and All Seasons in Marion County with good satisfaction. (Gardner).

Illinois: Unusually prevalent this year. (Anderson).
Especially in commercial region in Peoria County. (Tehon).

Michigan: Localized, 75 acres reported complete loss. (Coons).

Wisconsin: More prevalent. Important where resistant seed was not used in infested soil, Dane and Grant Counties. Failure of so-called resistant seed indicates liability of error to occur in commercial handling of resistant strains. Wholesale production of Wisconsin All Seasons being handled through cooperation with National Kraut Packers' Association, care of Martin Meeter, Lansing, Illinois. (Vaughan).

Kansas: Eastern and central parts, severe. Test in Butler County showed Wisconsin All Seasons resistant and Early Hollander susceptible. (Stokdyk).

The following as to production of yellows-resistant cabbage seed has been prepared by W. W. Gilbert of the Office of Cotton, Truck, and Forage Crop Disease Investigations:

"The production of yellows-resistant cabbage seed is now being handled on a commercial basis by cooperation through the Wisconsin Experiment Station and the National Kraut Packers' Association. The past season approximately 3600 pounds of seed of Wisconsin All Seasons and about 100 pounds of the Wisconsin Brunswick variety were grown in the Puget Sound District and were distributed to the trade and to State Experiment Stations and experimental services interested.

Arrangements have been made for the continued production of seed of these varieties, and work is being continued looking toward the development of other resistant types to fill the need not met by existing resistant varieties."

J. C. Walker makes the following statement:

"Cabbage yellows was very severe in old cabbage sections in southern Wisconsin, throughout Illinois, Indiana, Ohio, and Virginia.

"Wisconsin Hollander seed was distributed quite widely throughout the trade and in general gave good satisfaction. In a few cases unsatisfactory results were reported, all of these being traced to a single lot of seed which evidently had become adulterated at some time during its growth or distribution. Approximately ten pounds of Wisconsin All Seasons seed was distributed for trial in several states and uniformly excellent results were reported. About 3600 pounds of this variety and 100 pounds of Wisconsin Brunswick were grown in 1921 and distributed to the trade by the National Kraut Packers' Association for use in 1922 and 1923."

Recent literature

Fromme, F. D. The yellows disease of cabbage in southwest Virginia. Virginia Agr. Exp. Sta. Bul. 226: 9 p. Illus. Nov. 1921.

Jones, L. R., J. C. Walker, and W. B. Tisdale. Fusarium resistant cabbage. Wisconsin Agr. Exp. Sta. Res. Bul. 48: 1-34. Fig. 1-10. Nov. 1920.

Black rot caused by Bacterium campestre (Pam.) EFS.

Cabbage black rot caused considerable loss in some areas in 1921. In Wisconsin the loss was estimated at 5% of the crop, and in New York at from 2-5%. Texas and Maryland report a loss of 1%, Minnesota and Delaware .5%. Ten percent damage occurred in some fields in northern Florida in March and April. The following states reported the disease as occurring but of slight importance: Vermont, Rhode Island, Pennsylvania, West Virginia, Michigan, Iowa, North Dakota, South Dakota, and Kansas.

J. C. Walker reported as follows:

"Wherever noted, black rot was quite general when introduced, but confined to certain fields or to the product of certain seed lots in a given field. Evidence all pointed strongly toward introduction on seed."

For collaborators' comments, see Pl. Dis. Bul. 5: 50, 68, 136. 1921.

Blackleg caused by Phoma lingam (Tode) Desmaz.

In general, cabbage blackleg was less destructive in 1921 than in previous years. Walker[1], and Walker and Tisdale[2] confirm previous work as

to the importance of rainfall in the development of blackleg on seedlings. At Madison, Wisconsin 65% of the plants showed leaf or stem lesions and at La Conner, Washington, 3%. Comparative rainfall records for May, June, and July, respectively, at Madison were 5.13, 3.52, and 2.46 inches; and at La Conner 1.89, 1.90, and 0.00; thus only a slight development of blackleg occurred at the latter place. It is doubtful whether this amount of disease would have persisted after transplanting. One seed field at La Conner grown from stock seed which developed 75% of blackleg under Wisconsin conditions showed no signs whatever of infection. These results indicate the value of cabbage seed growing in the Puget Sound section to eliminate blackleg.

Table 86. Prevalence of and estimated losses from blackleg of cabbage, 1921.

State	Estimated loss	Remarks
New York	t-1%	Less, too dry while plants were in seedbed
Pennsylvania	-	Eastern part
New Jersey	-	Frequent in southern part
Delaware	.5%	First seen July 10 at Guyencourt
Maryland	1.5%	Less
Virginia	3%	General
West Virginia	t	In Ohio Valley
Louisiana	-	Very slight
Arkansas	10%	General, always severe
Ohio	-	Serious in a few fields
Indiana	.2%	Seen March 18 on plants from Georgia
Wisconsin	5%	Hot water seed treatment most efficient
Minnesota	t	Very light infection found in Wabasha and Ramsey Counties
Iowa	t	

J. C. Walker of the Office of Cotton, Truck, and Forage Crop Disease Investigations reports the disease as very common and destructive in Shocton and Appleton districts, Wisconsin. Found in minor quantities at Racine, Wisconsin; Lansing, Illinois; Clyde, Ohio; and Marion, Virginia.

Recent literature

1. Walker, J. C. Seed treatment and rainfall in relation to the control of cabbage blackleg. U. S. Dept. Agr. Bul. 1029: 1-27. Pl. 1-2. fig. 1. March 28, 1922.
2. Walker, J. C. and W. B. Tisdale. Further notes on occurrence of cabbage blackleg. (Abstract) Phytopath. 12: 43. Jan. 1922.

Black leaf spot caused by Alternaria brassicae (Berk.) Sacc.

Black leaf spot was reported as of minor importance in Delaware, Rhode Island, New York (pod spot, less), Texas, Indiana, Illinois, and Wisconsin.

The following table, which should perhaps be interpreted as the "Black rot" of the trade, rather than specifically as black leaf spot is compiled from market inspection reports:

Table 87. Losses from black leaf spot of cabbage caused by Alternaria brassicae, as shown by examination of cars at destination by food-products inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Remarks
Colorado	1	50	1	50	On outer leaves
Florida	9	14	1	43	
			8	5-27	
Illinois	1	100	1	100	1-3 outer leaves
New York	7	26	1	100	2-4 outer leaves
			3	13-33	
			3	2-5	
Pennsylvania	1	5	1	5	
South Carolina	3	45	3	35-50	
Texas	1	50	1	50	
Unknown	1	95	1	95	2-4 outer leaves

Total number of cars with black leaf spot....... 24
Total number of cars of cabbage inspected....... 828

Gray mold rot caused by Botrytis sp.

Table 88. Losses from gray mold rot of cabbage caused by Botrytis sp., as shown by examination of cars at destination by food-products inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: Number of cars	Range of percentage of decay: Percent
Iowa	1	20	1	20#
New York	13	67	5	100*
			7	35-80*
			1	5
Pennsylvania	1	5	1	5*
Wisconsin	3	56	2	75-77*
			1	15*
Unknown	1	50	1	50*

Total number of cars of cabbage with gray mold rot.... 19
Total number of cars of cabbage inspected............. 828

* Associated with slimy soft rot   # Associated with Rhizopus

Other diseases

Downy mildew caused by Peronospora parasitica (Pers.) De Bary was reported from New York; Philadelphia County, Pennsylvania; Louisiana; Texas (mostly in seed beds); and Wisconsin. Chupp reports the disease as quite

serious on cabbage seed pods in Suffolk County, Long Island, but controlled by Bordeaux with resin-sal soda sticker.

Ring spot caused by Mycosphaerella brassicicola (Duby) Lindau was a controlling factor in California where it caused a 15% reduction in yield of cabbage and other cruciferous plants according to Milbrath. The disease was localized in the San Francisco (Colma) district. The high humidity and low temperature seem significant. W. S. Fields comments on the cold foggy days common in that section as undoubtedly favoring the disease and states that no control measures are practiced.

Peppery leaf spot caused by Bacterium maculicolum McCulloch - reported from Long Island, New York as unimportant.

Slimy soft rot caused by Bacillus carotovorus Jones was reported as unimportant in Vermont, Pennsylvania, Texas, and Wisconsin. It caused slight damage in Minnesota in Wabasha County, and .5% loss in Maryland. A bacterial soft rot caused considerable loss in the late crop in Ohio by rendering the heads unfit for storage or shipping. Slimy soft rot of cabbage was reported generally occurring in carload shipments, but car conditions as to temperature and moisture play such an important role in bringing about development of the rot that data are not given.

Drop caused by Sclerotinia libertiana Fokl. was reported of local importance in West Virginia, Virginia, Louisiana, Texas, and Indiana.

Damping off caused by Rhizoctonia solani Kühn was reported as doing damage in March in seed beds in Sandusky County, Ohio, and at Westville, Connecticut. Clinton states that cabbage is a new host for this organism in Connecticut.

Southern wilt caused by Sclerotium rolfsii Sacc. was reported by Taubenhaus as unimportant in Texas.

Root knot due to Heterodera radicicola (Greef.) Müll. was reported as unimportant in Texas.

Lightning injury occurred at Northford, Connecticut, June 18. Lightning struck ground June 11, injured cauliflower, tomatoes, and lima beans as well as cabbage in the vicinity where it struck. On cabbage, injury often at tips of leaves (probably moisture there attracted electricity directly). (Clinton).

CAULIFLOWER AND BROCCOLI

Club root caused by Plasmodiophora brassicae Wor. was reported from Ohio and Vermont as doing slight damage to the crop in general; and from New York where Chupp reports the disease as important in Suffolk County, causing a reduction in yield ranging from a trace to 2%. Temple reports the greatest loss in western Maryland where a damage of 20% was experienced. (See also cabbage).

Black rot caused by Bacterium campestre (Pam.) EFS. was reported from Ohio as doing slight damage in Wayne, Cuyahoga, Washington, and Lawrence Counties.

Ring spot caused by Mycosphaerella brassicicola (Duby) Lindau - See cabbage.

Head rot of broccoli, thought to be due to bacteria, was reported by Barss from Oregon as follows: "Causes soft decay of head coming into bloom. Destroys flowering. Appears to have a bacterial organism associated as probable cause. Troublesome only in spring on heads carried over for seed production. Reported only from Corvallis. First noticed April 29."

Chlorosis of cauliflower is reported by Dana from King County, Washington.

Lightning injury was reported from Northford, Connecticut, June 18. (See page 364).

BRUSSELS SPROUTS

Blackleg caused by Phoma lingam (Tode) Desmaz. is reported from New York, collected August 30 at Clintondale. (Chupp).

CHINESE CABBAGE

Mosaic (see turnip).

HORSERADISH

Leaf spot caused by Cercospora armoraciae Sacc. collected at Hinton, West Virginia, August 5 by R. J. Haskell.

Leaf spot caused by Ramularia armoraciae Fckl. reported from western Washington.

White rust caused by Albugo candida (Pers.) Ktz. - Collected at Bustleton, Pennsylvania, August 27 by R. J. Haskell.

Bacterial root rot is reported by Poole as causing losses ranging from 4 to 28% on farms near Newark, New Jersey. Storage rot develops to the extent of 25 to 50%. Such roots either fail to germinate or produce stunted plants. Excision of rotted parts and disinfection with bichloride of mercury 1-1000 or formaldehyde 3 pints to 50 gallons for 30 minutes were effective control measures.

Poole, R. F. Bacterial root rot of horseradish in New Jersey. (Abstract) Phytopath. 12: 49. Jan. 1922.

Poole, R. F. Horseradish root rot investigations. Rep. Dept. Plant Path. New Jersey Agr. Coll. Exp. Sta. 1919/20: 610. 1921.

Root rot caused by Rhizoctonia sp. - reported as common in western Washington.

Black streak, cause undetermined, is reported from western Washington by Frank. "This appearance on the stems of the leaves and the mid-veins was again very common. It does not appear during the early part of the season, but in mid-summer and later it is very common."

KALE

Yellows caused by Fusarium conglutinans Woll. is again reported by Gardner as severe in market gardens in Marion County, Indiana, where it was first noted May 20, nearly a month earlier than the first appearance in 1920. The high temperature of June and July is said to be favorable to infection.

Club root caused by Plasmodiophora brassicae Wor. was reported from Erie County, New York, August 23.

MUSTARD

Mosaic (see turnip).

RADISH

White rust caused by Albugo candida (Pers.) Ktz. was reported as unimportant in Indiana where it was first noticed May 25; and Colorado where it occurred in August at Fort Collins. It was found as a serious disease in greenhouse radishes at Saginaw, Michigan, on February 9.

Downy mildew caused by Peronospora parasitica (Pers.) De Bary was reported as unimportant in Indiana, although it attacked the leaves of plants in hotbeds severely. It was first noticed at Indianapolis on April 27.

Club root caused by Plasmodiophora brassicae Wor. was found by Barrus on August 23 in one garden in Erie County, New York.

Black root caused by Rheosporangium aphanidermatus Edson[1] has been reported in the records of the Survey as follows:

Illinois: Present in 9 counties, doing 25-100% damage. (Barrett, 1911). (Under name Aphanomyces laevis De Bary) 1911 and 1912.
Indiana: (Aphanomyces laevis) reported 1911, 1912, 1914, 1916, 1917; (Rheosporangium) 1919 - fairly common, doing some damage.
Michigan: Reported from Lansing, 1912 (not named).
New York: (Aphanomyces) Specimen received from Long Island, 1912.
Wisconsin: (Aphanomyces) Specimen found May 1913 in University Garden, reported same year from Fond du Lac, Oshkosh, and Geneva.
Mississippi: Seventy to ninety percent infection in one field at Long Beach, May 3, 1919.

Edson[1] gives the following range for the black root of radish: District of Columbia, Maryland, Virginia, Long Island, and several points in Wisconsin. In this reference it is also pointed out that the fungus is pathogenic to beet seedlings.

Reports for 1921 extend the known range of this disease to Pennsylvania, where Thurston and Orton report heavy loss to radishes both under glass and out of doors in York County. Gardner and Kendrick report the disease as worse in Indiana and very destructive on both early and late season white varieties, reducing the yield for the state .5%. It seems to be most severe in central Indiana. The cool temperatures of early spring and late fall favor the disease. It is worst on Icicle varieties, but was noted on Early Long Scarlet, Early Vienna, and Cincinnati Market. (See also sugar cane root rot).

1. Edson, Howard Austin. Rheosporangium aphanidermatus, a new genus and species of fungus parasitic on sugar beets and radishes. Jour. Agr. Res. 4: 279-292. Pl. 44-48. July 1915.

RUTABAGA

Black rot caused by Bacterium campestre (Pam.) EFS. was reported by Vaughan as more important than usual in northern Wisconsin. The reduction in yield was estimated at 1%.

TURNIP

Mosaic was reported simultaneously on turnip by Gardner and Kendrick and on Chinese cabbage, mustard, and turnip by Schultz. The disease is infectious and is transmitted by plant juice (rubbing) and by aphids (Myzus persicae Sulz.). Gardner was not able to infect radishes with the virus. In his report to the Survey, he states that it was not of common occurrence on turnips in Indiana in 1921. The roots of mosaic plants are stunted. The disease was noticed first on turnips on July 26 at Lafayette, but the related mosaic on wild mustard was observed as early as April 25 at Indianapolis.

Gardner, M. W. and J. B. Kendrick. Turnip mosaic. Jour. Agr. Res. 22: 123-124. Pl. 20. Oct. 15, 1921.

Schultz, E. S. A transmissible mosaic disease of Chinese cabbage, mustard, and turnip. Jour. Agr. Res. 22: 173-178. Col. pl. B, pl. 22-24. Oct. 15, 1921.

Downy mildew caused by Peronospora parasitica (Pers.) De Bary was reported again from Texas.

White rust caused by Albugo candida (Pers.) Ktz. was reported as prevalent in Texas.

Anthracnose caused by Colletotrichum higginsianum Sacc. was reported as unimportant in Oconee County, South Carolina, where it was first seen October 13.

Powdery mildew was reported from Goshen, Indiana.

Alternaria leaf spot was reported from Goshen, Indiana by Gardner.

Yellows caused by Fusarium conglutinans Woll. - found destructive in a market garden at Lafayette, Indiana.

Club root caused by Plasmodiophora brassicae Wor. - reported from Jefferson County, Pennsylvania.

DISEASES OF CUCURBITS

CANTALOUPE

Leaf blight caused by Alternaria brassicae nigrescens Pegl.

Leaf blight was reported from Pennsylvania, Delaware, Maryland, Texas, Indiana, Illinois, Michigan, and Missouri. All states except Maryland, Michigan, and Missouri report the disease as serious. In Texas it caused a loss estimated at 1%. It was observed on July 19 in Indiana and August 9 in Delaware. In the latter state control has been secured with both Bordeaux mixture and Bordeaux dust. Gardner reports that the disease is severe in Indiana where rotation is not practiced, which is probably true in all melon growing areas. Rotation along with seedbed sanitation would doubtless completely handle the situation, providing seed transfer does not occur. However, it is the prevailing practice among growers to follow melons with melons. Given frequent summer rains, infection from trash makes blighting severe. Many sections are using resistant varieties. E. A. Bierbaum, Assistant

County Agent of Union County, Anna, Illinois, reports that growers are planting Pollock melons, particularly the strains known as "Ten" and "Ten Twenty-five". "These have been found to be more or less rust resistant and are meeting with fairly good success. Hearts of Gold and Netted Gem are also used, but our men are taking stronger every season to the Pollock melons." P. K. Blinn, Rocky Ford, Colorado states, "I feel safe in the assertion that practically nine-tenths of all the cantaloupes in the great commercial cantaloupe growing districts are planted with seed of some strain selected from the original disease-resistant Pollock cantaloupe. The Rocky Ford Cantaloupe Seed Breeders' Association have over 1500 individual plant selections of the most highly resistant and most uniform producing types."

Bacterial wilt caused by <u>Bacillus tracheiphilus</u> EFS

Bacterial wilt was reported from New York, Pennsylvania, Maryland, Virginia, West Virginia, Tennessee, North Carolina, Indiana, Illinois, Michigan, and Missouri. New York, Pennsylvania, Maryland, Virginia, Michigan, and Missouri report, in general, slight loss to the state, but occasional outbreaks. On the other hand, in West Virginia Giddings estimates the loss at 25% of the crop, and in North Carolina Foster states that the disease is fairly destructive. Clayton states that the disease has been severe and losses were heavy in Ohio. In Indiana, where the disease first appeared June 28, Gardner estimates the loss at 3% of the crop. The checking of the disease by hot weather, which has been noticed before and which may be associated with the low thermal death point of the organism, is indicated as operative in this report from Thomas in Ohio: "Comparatively slight evidence of the disease has been noticed since the first of August."

Anthracnose caused by <u>Colletotrichum lagenarium</u> (Pass.) Ell. & Hals.

Anthracnose was of slight importance in New Jersey, Pennsylvania, Tennessee, North Carolina, Ohio, Indiana, and Wisconsin. Burger believed the disease to be about as usual in Florida, although he had no reports of it. On the other hand, Melchers reported the disease as quite common on the foliage, causing death of the vines in Kansas. In West Virginia the disease was said to be general and more prevalent than in the average year, but only locally severe. Only one collection on a volunteer plant was made in Indiana at Mooresville, September 15. In Colorado, according to Learn, anthracnose was reported from near Denver, where it had caused the loss of about half the crop of two growers.

Mosaic (cause undetermined)

In reply to the August 15 questionnaire, collaborators in West Virginia, North Carolina, South Carolina, Ohio, and Kansas reported cantaloupe mosaic as "unreported to date", and in New Jersey as "unimportant" In Delaware, which is the only eastern state reporting the disease as important, mosaic is general and increasing in prevalence, producing a loss of 15% according to Adams. In Pennsylvania, Indiana, and Wisconsin the disease is considered to be of minor importance. Milbrath reports the reduction in yield for a district of 2500 acres in the San Joaquin Valley, California,

at 45%. The disease has shown a periodicity there, being very severe in 1919, not occurring at all in 1920, and with a serious outbreak during the past season. E. A. Bierbaum at Anna, Illinois states that a campaign is being conducted this spring (1922) to destroy all wild cucurbits and milkweeds in that vicinity as well as for better control of the striped cucumber beetles and melon lice. This is an experimental measure, based upon Doolittle's findings that the perennial wild plants harbor the mosaic virus and that this virus is brought to the cultivated fields by insects.

Fruit rot caused by *Fusarium* spp.

Anderson reports the late crop especially badly affected on account of the wet fall in Illinois. In Indiana Gardner reports rotting by Fusarium invading growth cracks due to the late growing season.

The following record of decay in shipments is probably concerned with the same type of trouble:

Table 89. Losses from Fusarium rot of cantaloupe caused by *Fusarium* spp., as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: Number of cars	Range of percentage of decay: Percent
Arkansas	7	4	7	1-10
California	8	17	1	65
			7	1-25
Colorado	1	2	1	2
Florida	2	11	2	3-19
Indiana	3	17	3	2-30
Maryland	1	2	1	2
Nevada	1	20	1	20
North Carolina	3	19	3	4-33
Unknown	2	4	2	4-5

Total number of cars with Fusarium rot.............. 28
Total number of cars of cantaloupes inspected....... 231

Rots caused by various organisms

Various decays are the cause of heavy losses in cantaloupes under transportation conditions. The significance of the rots in the field is largely unknown or disregarded. Under shipment conditions, bruised, delayed, or over-ripe fruit shows severe shrinkage as is shown in the following table; which gives the losses reported by food-products inspectors of the Bureau of Markets and Crop Estimates as due to *Rhizopus* sp.; to green mold rot caused by *Cladosporium* sp.; to black mold rot caused by *Alternaria* sp.; and to bacterial soft rots.

Table 90. Losses to cantaloupes in transit from various rots as reported by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	Approximate No. cars inspected	Amount of decay							
		Rhizopus		Green mold rot		Black mold rot		Bacterial soft rot	
		No. cars	Per cent	No. cars	Per cent	No. cars	Per cent	No. cars	Per cent
Arizona	9	1	2	-	-	-	-	-	-
Arkansas	18	6	21	-	-	-	-	1	10
California	102	7	6	4	23	3	16	2	13
Colorado	12	-	-	-	-	-	-	1	2
Delaware	6	-	-	-	-	-	-	-	-
Florida	3	1	1	-	-	-	-	-	-
Georgia	8	2	33	-	-	-	-	-	-
Indiana	5	-	-	-	-	-	-	-	-
Maryland	1	-	-	-	-	-	-	-	-
Missouri	2	-	-	-	-	-	-	-	-
Nevada	1	-	-	-	-	-	-	-	-
New Mexico	1	-	-	-	-	1	43	-	-
North Carolina	25	5	8	-	-	1	20	1	10
Ohio	1	-	-	-	-	-	-	-	-
South Carolina	18	7	8	-	-	1	2	-	-
Texas	5	1	1	-	-	-	-	1	8
Unknown	14	2	31	1	4	1	60	-	-
Total	231	32		5		7		6	

Other diseases

Downy mildew caused by *Pseudoperonospora cubensis* (B. & C.) Rostow - was reported as general in Sussex and Kent Counties, Delaware, being first seen in July at Delmar. The warm, showery, humid weather which prevailed in the state in the first half of July may have been a factor in making the downy mildew severe. Sherbakoff found the disease at Chattanooga, Tennessee August 11. The disease was found at Poplarville, Mississippi in July, causing extensive defoliation in the field and was also observed on the College grounds.

A bacterial leaf spot (undetermined) was reported from Columbia County, New York by Chupp.

Leaf spot caused by *Cercospora cucurbitae* E. & E. was reported as prevalent in Sussex and Kent Counties, Delaware, appearing at Delmar in July, the first report for the state. Always observed accompanying leaf infection by downy mildew (Adams).

Fruit rot caused by *Cladosporium cucumerium* El. & Arth. caused 2% loss in Honey Dew melons, in California, according to Milbrath.

Wilt caused by *Fusarium* spp. was reported from a wider range of territory than in 1920. In California the loss was estimated at 2%, the disease being prevalent in Stanislaus, Merced, and Modesto Counties (Milbrath). Brown reports the disease from Nogales and St. David, Arizona on June 7 and July 23.

Hopkins considers the disease to be increasing in importance in Missouri. Adams reports slight loss at Milton, Delaware, July 18.

Sclerotium blight caused by Sclerotium rolfsii Sacc. was reported as unimportant in Texas.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported as unimportant in Texas, but in the Imperial Valley, California, severe infestation existed in certain districts, causing a reduction in yield for the state of 5%. The range of loss was from .5% to 60% and when it is considered that 21,000 acres of melons were grown in this Valley, the aggregate loss is enormous.

Copper dust injury. Considerable burning of the vines was experienced in Delaware as a result of heavy applications of Bordeaux dust. The vines recovered but were two weeks late. (Adams).

CUCUMBER

Bacterial wilt caused by Bacillus tracheiphilus EFS

Collaborators in Connecticut, New York, Maryland, North Dakota, and California report bacterial wilt as of very slight importance in 1921. On the other hand, it is said to be the worst disease of cucumbers in West Virginia and Indiana, and was reported as severe in Wisconsin, Iowa, and Kansas. It caused considerable damage in Ohio also and was prevalent in Texas. Table 91 gives the losses from and prevalence of the disease.

Table 91. Relative prevalence of and estimated losses from bacterial wilt of cucumber, as reported by collaborators, 1921.

State	Importance 1921	Prevalence compared with 1920	Prevalence compared with Av. year	Range	Percent loss	Reported by
Connecticut	One complaint	More	Average	-	-	Clinton
New York	Not important	Less	-	With crop	t	Chupp
Maryland	-	-	-	-	t	Jehle & Temple
West Virginia	Most important disease	More	More	General	10	Giddings
Texas	Prevalent	-	-	-	1	Taubenhaus
Ohio	Considerable	About same	Same	General	-	Thomas
Indiana	Worst disease	Same	Same	With crop	5	Gardner
Illinois	Severe	-	-	Northern; general	-	Doolittle
Michigan	Severe	-	-	-	-	Doolittle
Wisconsin	Serious	More	More	General	2	Doolittle
Iowa	-	Same	Same	-	12	Melhus
North Dakota	Unimportant	About same	Same	-	-	Weniger
Kansas	Serious	-	-	Eastern	-	Melchers
California	Slight	Slight	Slight	-	.1	Milbrath

S. P. Doolittle, who watched cucumbers closely again this summer, makes the following report concerning bacterial wilt:

"Bacterial wilt was unusually severe in Wisconsin and northern Illinois and for the first time in the last five years was of serious economic importance in these states. The disease was found in all fields examined and the average infection was from 5 to 8% or about 100% greater than in 1920. A few fields showed a maximum infection of from 20 to 30% and the losses throughout the state of Wisconsin were sufficient to probably reduce the crop 2%. The disease appeared about July 1, and continued to spread rather rapidly up to August 15. Reports from Indiana and Michigan indicated a similar situation in these states."

Dates of first observed appearance of bacterial wilt of cucumber, 1921

June 2.................. Wyandotte County, Kansas
June 22.................. Wood County, Ohio
July 1.................... Wisconsin
July 7.................... Lafayette, Indiana
August 8.................. Branford, Connecticut

The suggestion made by Rand and by others that the striped cucumber beetle carries the wilt organism through the winter has been confirmed by Doolittle[1].

Recent literature

1. Doolittle, S. P. Overwintering of the bacterial wilt of cucurbits. Phytopath, 11: 299-300. 1921.
______________ Comparative susceptibility of European and American varieties of cucumbers to bacterial wilt. Phytopath. 12: 143-146. March 1922. (June).

Mosaic (cause undetermined)

Cucumber mosaic was reported from Maryland, Texas, Illinois, Iowa, North Dakota, and Michigan as being less severe than in previous years.

S. P. Doolittle summarizes the condition regarding cucumber mosaic in the central pickle growing areas in 1921 as follows:

"The average losses from cucurbit mosaic in Wisconsin and Illinois appeared to be approximately 70% of those of average years and not more than 50% of those in 1920. About 60% of all fields examined showed the disease, but owing to its slow dissemination during 1921, many fields were not infected until late. The infection varied from a trace up to 100% in individual fields. The average number of plants infected on September 1 was probably about 30%. The reduction in the injury from mosaic was partly due to the reduced number of aphids in most sections where they were numerous in 1920. Observations over a number of seasons have shown that the injury from mosaic fluctuates directly with the presence or absence of this and other cucumber insects. Losses in Wisconsin were probably

about 12% from mosaic. Reports from Michigan and Indiana indicated some reduction in injury as compared with 1920."

Table 92. Relative prevalence of and losses from cucumber mosaic, 1921.

State	Importance	Prevalence compared with: 1920	Av. year	Percent: loss	Reported by
New York	Very important especially on Long Island	As much or more	-	25-50	Chupp
Maryland	-	-	-	t	Jehle & Temple
Texas	Unimportant	-	-	-	Taubenhaus
Indiana	Serious factor	Less	Less	2	Gardner
Illinois	Important	Less	Less	-	Doolittle
Michigan	-	Probably less	-	2	Doolittle, Coons
Wisconsin	Important	Much less	Much less	12	Doolittle
Iowa	-	Less	-	5	Melhus
North Dakota	Locally destructive	Same	About same	-	Weniger
California	Severe in green houses	-	-	3-5	Milbrath

W. W. Gilbert reports 100% infection in cucumber fields on the Arlington Experimental Farm in Virginia. Chupp reports the disease as very important in New York, being especially serious on Long Island, beginning to show when plants are ten days old, and being found in as high as 100% prevalence in some fields. He quotes a report of his office as follows: "Two-thirds of the crop lost in Nassau County. Farmers are quitting the growing of pickles."

M. B. Church[1] reports the results of preliminary work which indicates that mosaic affected cucumbers will not cure properly in the pickling process.

Doolittle and Walker[2] state that mosaic milkweeds are an evident source of primary infection in cucumber fields. Cross-inoculation experiments indicate a possible transmission of cucurbit mosaic to the potato by means of aphids. Aphids taken from the potato plants so inoculated produced mosaic symptoms on cucumbers. Mosaic-cucumber aphids transferred to healthy pokeweed plants produced symptoms of mosaic in three out of five cases. The results of these transmission experiments give indication that some very interesting developments are to be expected from further work.

Recent literature

1. Church, M. B. The relation of mosaic disease to pickling of cucumbers. Phytopath. 11: 28-29. Jan. 1921 (Febr.).
2. Doolittle, S. P. and M. N. Walker. Notes on cucurbit mosaic. (Abstract) Phytopath. 12: 42-43. 1922).

Angular leaf spot caused by Bacterium lachrymans EFS. & Bryan

This disease of cucumber, which is not known to occur on watermelon, squash, or muskmelon, occurs in North America and Europe. It has been reported

from Alabama, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Louisiana, Michigan, Minnesota, New York, North Dakota, Ohio, South Carolina, Virginia, Wisconsin, and is found also in Ontario and Quebec (Meier and Link).

In 1921 the disease was reported from Florida, Indiana, Illinois, Michigan, Wisconsin, Iowa, and California. In general, it was less important than usual, although it caused considerable fruit rot late in the season, in some localities.

S. P. Doolittle makes the following statement regarding the disease in the Middle West:

> "Angular leaf spot did not appear in Wisconsin and northern Illinois until about July 25. In southern Wisconsin it did little serious damage as it did not develop to any extent until the season was nearly over. Reports from central and northern Michigan and northern Wisconsin, however, indicated that in some sections the disease was causing a serious rotting of the fruits in a number of fields. The average infection noted was from 5-25% with about 35% of the fields infected by August 25."

Drechsler and Meier (Cotton, Truck, and Forage Crop Disease Investigations News Notes, March 2, 1921) report the disease as widespread in cucumber-growing sections of Florida and as particularly serious where overhead irrigation is practiced. The season has been exceptionally warm. Gardner reports the disease unimportant in Indiana and states that seed treatment has practically eliminated the disease from the crop of a large pickling company. Coons found the disease causing heavy loss in Michigan, especially in producing secondary fruit rots at a seed farm. In Iowa 2% loss was incurred according to Melhus. Milbrath says that the disease was severe on Klondike variety in San Diego County, California, 30% of the plants being affected severely.

Jones and Doolittle[2] give additional evidence of seed transference of the organism and record destructive action on the young fruit in the field. Gardner and Gilbert[1] report the results of additional tests demonstrating the effectiveness of control by seed disinfection with mercury bichloride, 1-1000, for five minutes. Soil infestation did not occur and is believed not to be a factor. Two-year old seed cannot be considered free from this organism, but three-year old seed apparently does not carry the infection.

Recent literature

1. Gardner, M. W. and W. W. Gilbert. Field tests with cucumber angular leaf spot and anthracnose. Phytopath. 11: 298-299. July 1921 (Nov.).
2. Jones, L. R. and S. P. Doolittle. Angular leaf spot of cucumber. Phytopath. 11: 297-298. July 1921. (Nov.)

Anthracnose caused by _Colletotrichum lagenarium_ (Pass.) Ell. & Hals.

Apparently anthracnose was again of small consequence. Doolittle reported as follows:

> "Found in only a few fields in Wisconsin and Illinois, not over 5% of the fields affected and about 2-10% of the plants in these fields affected with the disease. Reports of serious losses in two

fields in northern Wisconsin and one in Michigan were received, the crop being reduced about 10% in these cases."

Only one report of this disease was received from New York, its damage in Maryland was but a trace, and in Iowa none was found. For West Virginia, Giddings reported more of the disease present than last year with a reduction in yield of 1% for the state. The disease was worse than usual in Indiana, being influenced by late rains. Anthracnose did a great deal of damage with the late maturing seed crop of cucumbers in Michigan, causing 50% loss to the seed crop in one locality, according to Coons.

Gardner and Gilbert (l. c., see angular leaf spot) report that the fungus did not persist twenty months in soil and that a two-year rotation would eliminate anthracnose soil infestation.

Downy mildew caused by Pseudoperonospora cubensis (B. & C.) Rostow

This disease was present to a very slight extent in Connecticut, Maryland, Ohio, and Wisconsin, but was not found in Illinois, Indiana, and Michigan. It was stated by Ludwig to be important locally in South Carolina. In Wisconsin the disease was found in two fields at Rockland, Monroe County, just appearing August 25, according to Doolittle.

Black rot caused by Mycosphaerella citrullina (C.O.Sm.) Gros.

Meier, Drechsler, and Eddy[1] report a fruit decay due to Mycosphaerella citrullina which is known as occasionally destructive to greenhouse muskmelons and watermelons in the southeast, but which has not previously been reported on cucumbers. Affected cucumbers develop water-soaked areas, which, although enlarging less rapidly than those caused by Rhizopus sp., may attain considerable size during the time required for transportation. (See also under squash).

1. Meier, Fred, Charles Drechsler, and Emery Eddy. Cucumber black rot caused by Mycosphaerella citrullina. (Abstract) Phytopath. 12: 43. 1922.

Scab caused by Cladosporium cucumerinum Ell. & Arth.

Scab was reported from New Hampshire, Michigan, Wisconsin, and California. It seemingly was of importance only in the northern half of the Lower Peninsula of Michigan and there it assumed importance rather from peculiar trade conditions than from actual crop destruction. "The favorable season led to the production of a heavy crop of cucumbers and in some areas at the first outbreak of scab certain packers sought to refuse to purchase any of the crop and carry out their contracts with growers. This disease, therefore, indirectly led to a loss to farmers of approximately $2,000,000." (Coons).

S. P. Doolittle makes the following report:

"Scab was reported from Jackson and Marinette Counties in Wisconsin and from Grand Traverse County, Michigan, in all of which

localities it appeared to be causing some damage. The disease was not found at other points and apparently was of little economic importance over these states in general."

Fruit rots caused by various organisms

Various decays, which were found on cucumbers in transit, are reported in Table 93.

Table 93. Losses to cucumber from Rhizopus rot caused by Rhizopus sp., bacterial spot caused by Bacterium lachrymans, and soft rot (cause undetermined), as reported by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	Approximate No. cars inspected	Amount of decay					
		Rhizopus		Bacterial spot		Soft rot	
		Number cars	Per cent	Number cars	Per cent	Number cars	Per cent
Alabama	12	-	-	6	2	-	-
Arkansas	1	-	-	-	-	-	-
California	3	-	-	-	-	-	-
Delaware	2	-	-	1	1	-	-
Florida	43	6	9	22	13	11	6
Georgia	2	-	-	-	-	1	3
Illinois	1	-	-	-	-	-	-
Louisiana	5	-	-	-	-	1	12
Maryland	9	1	2	2	3	1	7 W
Michigan	1	1	8BS	1	8R	-	-
Mississippi	1	-	-	-	-	-	-
New York	2	-	-	-	-	-	-
North Carolina	23	1	2	3	11	5	6
Ohio	1	-	-	1	13M	-	-
South Carolina	16	-	-	7	14	3	5
Texas	6	1	5P	-	-	1	1
Unknown	9	-	-	3	7	1	5BS
Totals	137	10		46		24	

BS Associated with bacterial spot
M Mostly black rot (Mycosphaerella)
W Associated with white mold rot
P Some Phoma rot
R Associated with Rhizopus rot

Other diseases

Sclerotinia rot caused by Sclerotinia libertiana Fckl. was reported from Idaho (unimportant, noted in gardens after fall rains began - Hungerford) and California (in greenhouses during the period of January to June, causing .5% loss - Milbrath).

Root knot caused by Heterodera radicicola (Greef) Müll. was serious in greenhouses in Illinois and Pennsylvania; and occurred in the field in Texas.

Chlorosis was reported by Dana as occurring in Washington.

GOURD

Downy mildew caused by Pseudoperonospora cubensis (B. & C.) Rostow was reported by Gardner as occurring on one plant at Akron, Indiana, September 21.

Anthracnose caused by Colletotrichum lagenarium (Pass.) Ell. & Hals. was reported by Anderson of Illinois as very serious on a variety of edible gourds grown in University plantings. It occurred both as a fruit spot and a rot.

SQUASH

Bacterial wilt caused by Bacillus tracheiphilus EFS. was reported as doing slight damage in New York (observed 2 acres of Hubbard squash with 10% loss, at Chautauqua, July 25 - Chupp), Ohio (more; loss considerable with some growers; in northern half of state; greatest losses noted in storage, presumably due to late infection. - Thomas), Indiana, and Iowa.

Anthracnose caused by Colletotrichum lagenarium (Pass.) Ell. & Hals. was reported from Ohio.

A storage rot due to Gloeosporium sp. (not C. lagenarium) was found in local stores on the 1920 crop in Indiana, according to Gardner.

Downy mildew caused by Pseudoperonospora cubensis (B. & C.) Rostow was important locally in South Carolina. (Ludwig).

Leaf spot caused by Macrosporium cucumerinum E. & E. was reported from Genesee County, New York as important locally. (Chupp).

Mosaic was reported as unimportant in Texas. (Taubenhaus).

Black rot caused by Mycosphaerella citrullina (C.O.Sm.) Gros. - Kauffman, C. H. A black rot of squash. Rep. Mich. Acad. Sci. 22(1920): 201-202. 1921.

WATERMELON

Anthracnose caused by Colletotrichum lagenarium (Pass.) E. & H.

Watermelon anthracnose, which in 1920 was known largely from market inspectors reports, is in 1921 reported to be of considerable importance in certain northern as well as southern states. In addition to those whose comments are quoted below, collaborators in Mississippi, Louisiana, and Texas report the disease. (See also Pl. Dis. Bul. 5: 118-119. 1921.)

New Jersey: Abundant, but crop of little importance. (Cook).

Delaware: Very important; general; leaf infection more common than fruit. (Adams).

Maryland: Less prevalent, reducing yield 5%. (Jehle and Temple).

Virginia: No doubt general. (Fromme).

Table 94. Losses from watermelon anthracnose caused by Colletotrichum lagenarium (Pass.) E. & H., as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: Number of cars	Range of percentage of decay: Percent
Alabama	2	18	2	15-20
Arkansas	3	12	3	10-15
Florida	21	20	2	80-95
			3	30-40
			6	10-25
			10	2-8
Georgia	183	30	18	75-100
			27	50-74
			40	25-49
			89	5-24
			9	1-4
Indiana	14	22	4	35-65
			6	10-30
			4	3-7
Missouri	1	35	1	35
North Carolina	8	25	1	75
			6	10-35
			1	3
Ohio	1	7	1	7
Oklahoma	1	10	1	10
South Carolina	145	28	10	75-100
			17	50-70
			41	25-49
			73	5-24
			4	1-4
Texas	1	50	1	50
Unknown	7	21	1	50
			5	15-25
			1	2

Total number cars watermelons with anthracnose....... 387
Total number cars watermelons inspected.............. 994

West Virginia: Quite general, but severe only locally, loss to state 2%. (Giddings).

Tennessee: In certain fields very damaging. (Essary, Sherbakoff, and Hesler).

North Carolina: Important in Coastal Plain section. (Foster).

South Carolina: Of moderate importance in southwestern portion. (Ludwig).

Georgia: It was reported that watermelon anthracnose was unusually bad on early melons in southern Georgia. Later the dry weather seemed to check the disease. (Higgins).

Florida: Less than last year, about same as usual. General. Most important from May 15 to June 15. (Burger).

<u>Arkansas</u>: Severe in some fields, mostly leaf spot, some on fruits. Loss to the state, 5%. (Elliott).

<u>Ohio</u>: Slight, worse in southern section of the state. (R. C. Thomas).

<u>Indiana</u>: Very important, much worse than last year or than usual. Favored by excessive rainfall. Worse in central Indiana where season extended into rains of late summer. Most important in August, when fruit was maturing. (Gardner).

<u>Missouri</u>: Known to be general. (Hopkins).

<u>Kansas</u>: Important in some regions. Severe foliage infection caused crop to sunscald. In Riley County about 50% of the crop was lost. There was more moisture in July and August than normal. (Melchers).

<u>Colorado</u>: Present, important about Denver. (Learn).

<u>Arizona</u>: Present in southern Arizona. (Brown).

Supplementing the above reports by collaborators, the accompanying table (Table 94) compiled from market inspectors' reports is worthy of consideration. Even when field losses are reported as low, carlot shipments frequently showed from 75-100% decay from this cause upon arrival at northern markets. Out of nearly a thousand cars inspected, 25% showed upon the average 26% decay from this cause. It is very evident from this showing that watermelon anthracnose presents problems in disease control well worthy of attention.

The following report on dusting experiments with watermelon has been furnished by H. A. Cardinell. These tests seem to indicate that there is considerable promise in this method of control.

> "The test was conducted with dehydrated copper sulphate and hydrated lime, used at a ratio of 1 to 4, using 9 pounds of the mixture to the row*.
>
> "Applications made when the first melons were set and when the fruit was full grown, gave 12 melons in 8 rows with an average of 1 lesion of anthracnose per melon. The check, on the other hand, showed 24 badly spotted melons per row.
>
> "Dry Bordeaux applied in various strengths gave fair control with four applications and no control with 2 applications.
>
> "These trials with copper dusts did not give as good control as has been obtained in other states where four to nine applications of liquid Bordeaux have been made, but this one season's trial showed that good control might be expected had more applications been made."

<u>Recent literature</u>

Burger, O. F. Watermelon diseases. Quart. Bul. State Plant Bd. Florida. 5: 131-138. Illus. April 1921.

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* Experiments were with watermelons set 10 x 10 feet, 32 plants to the row. Yields were not taken. (Missouri).

Stem end rot caused by Diplodia Sp.

Stem end rot was not found in New Jersey, West Virginia, or South Carolina, and was reported for the most part as of slight importance in North Carolina, Maryland, Mississippi, Texas, and Louisiana. The disease is evidently present in the fields and develops to serious proportions in transit. Adams reported the disease as first observed in Delaware August 2 and as "very prevalent in early planted fields, being more common on new ground. Some fields showed 5% infection." Melchers reported the disease as occurring to some extent in most fields in Kansas. Neal believes the disease to have been checked in Mississippi by dry weather. Jehle and Temple estimated the loss as 1% in Maryland. Taubenhaus states that the disease was not important in Texas. Elliott places the loss in yield for Arkansas at 3%. Burger reports the disease as occurring in the field in Florida, but causing greatest loss during shipment. Where the stems of the melons were properly treated there was very little rot in transit, (see also Pl. Dis. Bul. 5: 119. 1921).

Table 95. Losses from stem end rot of watermelon caused by Diplodia sp., as shown by examination of cars at destination by inspectors of the Bureau of Markets and Crop Estimates, 1921.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: Number of cars	Range of percentage of decay: Percent
Alabama	2	11	2	7-15
Arkansas	3	10	3	6-15
Florida	61	12	3	50-85
			7	20-45
			26	5-18
			25	1-4
Georgia	354	12	2	75-100
			23	35-60
			233	5-33
			96	1-4
Indiana	29	4	29	1-10
Kentucky	1	50	1	50
Mississippi	2	15	2	6-25
Missouri	1	8	1	8
North Carolina	18	9	7	12-25
			11	1-8
Ohio	1	6	1	6
Oklahoma	1	6	1	6
South Carolina	118	15	6	50-80
			17	24-45
			73	5-23
			22	1-4
Texas	12	11	6	12-25
			6	2-5
Virginia	2	18	2	2-35
Unknown	22	7	10	8-20
			12	2-5

Total number cars of watermelons with stem end rot...... 627
Total number cars watermelons inspected.................. 994

F. C. Meier of the Office of Cotton, Truck, and Forage Crop Disease Investigations, conducted laboratory tests with various fungi associated with melon decay in the field, but secured no decay except with Diplodia. Infection was not secured with Diplodia without wounding the melons. Stem treatment tests were made which showed that where treatment was properly applied no decay resulted. A possible explanation of decay present last season in cars that showed evidence of treatment was found in the fact that six hours after inoculation the fungus penetrates the stem to a point where the fungicide paste is not effective. Very few growers last season followed instructions with regard to recutting the stem at the time of treatment.

With this disease, to a greater extent even than with anthracnose, the field aspects are enormously magnified when market conditions are considered. Out of nearly a thousand cars inspected at terminal markets, 627 or 63% were badly injured through this type of decay, the average percentage of decay being 13.

Blossom end rot (cause unknown)

Various fungi are known to bring about this condition, and it is suspected that weather blighting is also a factor and that many of the fungi isolated are secondary invaders. Diplodia spp., Fusarium spp., and Pythium sp. are reported by various collaborators as causal agents. The name, evidently, describes a general condition embracing several different types of disease. Adams reports blossom end rot, not connected with Diplodia, appearing August 2 at Bridgeville, Delaware. Valleau reports the disease as present in Kentucky. Taubenhaus reports the disease as prevalent in Texas, doing 1% damage; Elliott places the loss at 5% for Arkansas; Melhus states the loss for Iowa is 2%; and Hungerford notes the disease as present in the Lewiston district, Idaho.

Wilt caused by *Fusarium niveum* EFS.

Fusarium wilt was reported in 1921 as unimportant in Maryland and Mississippi, as locally important in Virginia, West Virginia, North Carolina, Illinois, and Iowa, and as general and important in Indiana, Missouri, and Texas. It was very destructive in some sections of North Carolina according to Foster, but as a rule infested soil has been abandoned for melon culture. In West Virginia Giddings states that the disease was seen only in the Ohio Valley where it was more severe than usual, reducing the yield 1% and being especially severe on light soils. The disease was less severe according to Gardner in central and southern Indiana because of low temperatures associated with excessive rains, but nevertheless it is the limiting factor in watermelon growing. Anderson reported it as serious in some localities of Illinois. It was reported by Melhus as local but serious where it occurs in Iowa. Hopkins considers the disease very important in Missouri and more severe than in the preceding year.

Dates of first appearance of watermelon wilt

May 30	Missouri	June 28	Woodford County, Ill.
June 28	Vincennes, Indiana	August 8	Lilburn, Powhatan Co., Va.

Other diseases

Downy mildew caused by Pseudoperonospora cubensis (B. & C.) Rostow was reported as very important and general in Sussex and Kent Counties, Delaware. It first appeared at Delmar in July. (Adams).

Leaf blight caused by Alternaria brassicae nigrescens Pegl. was reported by Adams as first observed in Delaware August 2. It was generally prevalent but did not develop serious infection as found on cantaloupes.

Leaf rot caused by Cercospora citrullina Cke. was reported from Texas.

Wilt caused by Bacillus tracheiphilus EFS. was reported from Kentucky as severe in the vicinity of Lexington. Raeder reported it as important in the melon growing regions of Idaho, causing a distinct wilting and killing of the plants. Milbrath states that it is an important factor in Los Angeles County, California, and estimates a 2% reduction in yield for the state.

Root rot caused by Rhizoctonia sp. was reported by Dana from Asotin County, Washington.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported by Milbrath as occurring in the Imperial and San Joaquin Valleys, California, and causing a reduction in yield for the state of .5%.

DISEASES OF COTTON

Anthracnose caused by Glomerella gossypii (Southw.) Edg.

Anthracnose was reported, in general, as less severe in 1921 than in the preceding year; the dry, hot weather of the summer serving to restrict spread and prevent serious loss in many areas. In North Carolina the disease was said to be common only in the southeastern portion, where rainfall was abundant. In years of abundant moisture, anthracnose is an important disease in the Delta section of Mississippi, according to Neal, but dry weather prevented its becoming so this year.

Table 96. Relative prevalence of and losses from cotton anthracnose, as reported by collaborators, 1921.

State	Importance 1921	Prevalence compared with: 1920	Av. year	Range	Percent loss
Tennessee	-	-	-	-	3
North Carolina	Common in southeast	Less	-	-	-
South Carolina	Moderate	More	Less	General	2
Georgia	-	-	-	-	2-5
Florida	Locally severe	-	-	-	-
Mississippi	Unimportant	Less	Less	General	3
Louisiana	Considerable	About same	About same	General	2-5
Texas	Prevalent	-	-	-	1
Arkansas	Fairly important	Less	Same	Mostly eastern half	1

Dates of first appearance of cotton anthracnose, 1921

July 8............... Summerville, South Carolina
July 20.............. West Point, Mississippi
September............ Scott, Arkansas

The following comments of collaborators are of interest: (See also Pl. Dis. Bul. 5: 104, 138. 1921).

Alabama: Next to wilt, most common cotton disease. (Povah).

Mississippi: The disease was not very important because of the dry season. (Neal).

Louisiana: Common in many localities and causing the usual loss. (Edgerton).

Arkansas: Fairly important; mostly in eastern half. Weather hot and fairly dry this season. (Elliott).

According to Colin G. Welles[1], anthracnose appeared in the Philippine Islands, where it had not previously been observed. The Colletotrichum stage was found on bolls of plants at the College of Agriculture, Los Banos. It is thought that strict quarantine of the College cotton, and careful seed selection will prevent the spread of the disease.

Literature cited

1. Welles, Colin G. Two serious plant diseases new to the Philippines. Philipp. Agr. 10: 253-254. Dec. 1921.

Wilt caused by *Fusarium vasinfectum* Atk.

Wilt was reported as general throughout the southern states, and seemed to have caused slightly greater damage than in the preceding year. The following table records the losses as reported by collaborators and the quotations below give additional data (see also Pl. Dis. Bul. 5: 103, 137. 1921).

Table 97. Relative prevalence of and losses from Fusarium wilt of cotton, according to collaborators, 1921.

State	Importance	Prevalence compared with: 1920	Av. year	Range	Percent loss
North Carolina	Most important disease	More	More	Coastal Plain and adjoining	10
South Carolina	Important	About same	About same	Southwestern	-
Mississippi	Important as usual	About same	About same	Rather general	5
Louisiana	Considerable	About same	About same	Sandy and upland sections	5
Texas	Prevalent	-	-	-	2
Arkansas	Always important	Less	Same	General	.8

North Carolina: Coastal Plain section and several counties adjoining this section. Occurred in 60% of the fields, as much as 100% infection in some. Excessive transpiration and evaporation due to hot dry weather caused plants to succumb to disease. (Foster).

Alabama: Susceptible varieties show considerable loss. (Povah).

Mississippi: Important as usual; 20% of the fields infested, most in any field 15%. Caused most injury during June and July when plants were from one-third to one-half mature. (Neal).

Louisiana: Considerable in sandy and upland sections. (Edgerton).

Arkansas: Always important; somewhat less this year; 75% of fields infested with total infection in some. General; most severe in east and south and on sandy soils. Weather hot and fairly dry. (Elliott).

The following comments by collaborators are important in throwing light upon the present status of the wilt-resistant varieties:

North Carolina: Wilt was reported on practically all varieties with the exception of Dixie and Triumph strains. (Foster).

South Carolina: Much of the damage is done by compelling the cultivation of the resistant varieties which in the absence of wilt are less desirable than some others. (Ludwig).

Mississippi: Resistant varieties used in the hill section are Tricook, Lewis 63, and Governor Teal. Webber 49 and Express selections are semi-wilt resistant and largely planted in the Delta. (Neal).

Arkansas: Express is the most resistant of the commonly grown varieties. (Elliott).

For a discussion of the general situation in the southern states as to resistant varieties, the Farmers' Bulletin 1187 by W. W. Gilbert[2] should be consulted. Elliott[1] has found recently that cotton wilt is seed-borne.

Literature cited

1. Elliott, John A. Cotton wilt, a seed borne disease. (Abstract) Phytopath. 12: 50-51. Jan. 1922.
2. Gilbert, W. W. Cotton diseases and their control. U. S. Dept. Agr. Farmers' Bul. 1187. 1-32. Fig. 1-18. March 1921.

Angular leaf spot caused by Bacterium malvacearum EFS.

This disease was reported in general as less severe in 1921 than in the previous year, but is still considered a very important disease in many of the states.

North Carolina: A loss of 1% was caused by the angular leaf spot. (Foster).

South Carolina: Dry weather apparently checked the disease a great deal in many parts of the state. Faulwetter's method of control by seed treatment was retested during the season and found effective. (Ludwig).

Mississippi: About the same importance as last year, reducing the yield for the state about 2%. (Neal).

Louisiana: Very common, and in some localities has caused considerable shedding of the leaves. (Edgerton).

Texas: Very prevalent. Three percent loss. (Taubenhaus).

Oklahoma: Considering the whole loss to stand and to leaves in their relation to yield, I believe the loss to be over 5%. (Stratton).

Arkansas: Less prevalent than last year, reducing the yield 2%. Sulphuric acid delinting gave complete control. (Elliott).

For report on seed treatment see the article by Ludwig[1].

Literature cited

1. Ludwig, C. A. The control of angular leaf spot of cotton. (Abstract) Phytopath. 12: 50. Jan. 1922.

Root rot caused by Ozonium omnivorum Shear

Ozonium root rot was reported in 1921 to the Plant Disease Survey only from Texas, where it was very prevalent, causing a loss of 20%, according to Taubenhaus. This disease, which is commonly reported as most severe on all

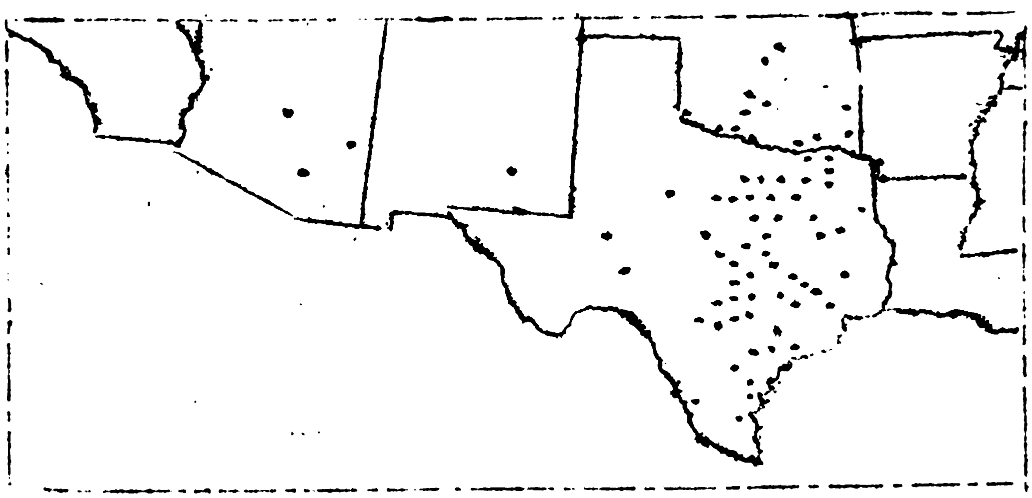

Fig. 83. Distribution of Ozonium omnivorum on cotton, according to records of the Plant Disease Survey, 1903-1921. Each dot represents a county from which the disease has been reported.

black, waxy limestone soils, is probably widespread in the southern tier of states west of the Mississippi on other soil types as well. Its distribution so far as the records of the Plant Disease Survey are concerned is given in the accompanying map (Fig. 83), with the hope that this charting will encourage close observation of present limits and of relations to soil types in order that fuller knowledge of the potentialities of the disease may be had.

Other diseases

Ascochyta blight caused by *Ascochyta gossypii* Sydow. This disease was reported in Supplement 16: 259. 1920, as due to *Phoma* sp., but determinations of Arkansas material made by W. B. Grove of Birmingham University, England, and comparison with authentic specimens of *Ascochyta gossypii* have shown that the causal organism is the latter fungus. In 1921 the disease began, in June, to cause considerable damage, but was checked by dry weather, so that it was much less important than in the preceding year, and caused only slight loss.

Elliott, J. A. A new Ascochyta disease of cotton. Arkansas Agr. Exp. Sta. Bul. 178: 1-18. Illus. April 1922.

Leaf spot caused by *Cercospora gossypina* Cke. was reported as doing slight damage in South Carolina and Texas.

Areolate cotton mildew caused by *Ramularia areola* Atk. was reported October 5 following heavy rains in Alabama. (Povah).

Rust caused by *Aecidium gossypii* E. & E. was reported as present in Hopkins County, Texas. (Taubenhaus).

Black rust attributed to *Alternaria* sp. was reported from Arkansas as completely defoliating cotton following angular leaf spot. (Elliott).

Boll rot, caused by various fungi, was reported from South Carolina and Arkansas as doing slight damage. *Diplodia gossypina* Cke. was definitely reported by Edgerton as causing about 2% damage in Louisiana.

Rhizoctonia rot, "sore shin", caused by *Rhizoctonia* sp. was reported as doing slight damage in Texas and Arizona.

Bacterial wilt caused by *Bacillus solanacearum* EFS. was artifically induced on young cotton seedlings. (See Smith, E. F. and G. H. Godfrey. Bacterial wilt of castor bean (*Ricinus communis* L.). Jour. Agr. Res. 21: 255-261. 1921). Older plants were resistant, however.

Wilt of unknown cause was reported by Ludwig as present in Oconee County, South Carolina, first seen July 21 at Walhalla. The trouble is different from the ordinary wilt.

Root knot caused by the attacks of *Heterodera radicicola* (Greef) Müll. was reported from North Carolina (common, 1% damage - Foster), South Carolina (important - Ludwig), Mississippi (unimportant - Neal), Louisiana (slight loss - Edgerton), Arkansas (1% loss - Elliott), and Texas (1% loss - Taubenhaus).

Potash hunger was reported as occasional in North Carolina, and as rather more common than usual in South Carolina due to a tendency to slight use of fertilizers during the period of depression. In Louisiana, Mississippi, and Texas this form of trouble was not noticeable, but on poor soils in Arkansas it was reported as fairly important, reducing the yield for the state by 2%. (Elliott).

DISEASES OF SUGAR CANE

Mosaic (cause undetermined)

E. W. Brandes of the Office of Sugar Plant Investigations gives the following summary of the mosaic situation in 1921:

"Sugar cane mosaic, according to authoritative information in the Office of Sugar Plant Investigations is present in Java, Egypt, Hawaii, Porto Rico, Santo Domingo, Virgin Islands, New Guinea, Philippines, Trinidad, Jamaica, Barbados, United States, China, Argentina, Cuba, in short in all the sugar producing districts of the world with the possible exception of India for which no authoritative reports exist. The distribution in the United States is restricted to Louisiana, Alabama, Georgia, Florida, and Mississippi. The distribution in Mississippi is based on reports of the Mississippi Plant Board which for the most part show the same counties as recorded last year. A report from L. E. Miles on August 15 shows the mosaic to be found at present on 111 properties of the 600 properties inspected. Inspections have been made in 45 counties and infections have been found in 16. At present mosaic infection is still known to occur in 12 counties; namely, Harrison, George, Greene, Jackson, Lamar, Lauderdale, Marion, Pearl River, Pike, Stone, Hancock, and Warren. The difference in records of 1921 and those of 1920 represents the eradication work being attempted. The distribution in Florida is the same as last year. The distribution in Alabama is restricted to Baldwin County."

The report by states is as follows:

Georgia: Sugar cane mosaic is known to occur in Brooks, Decatur, Grady, Mitchell, and Thomas Counties. (Brandes).
The effects of the extremely dry weather have masked the mosaic so as to prevent accurate estimates, but the crop is turning out 40 to 50% of normal. (Wright).

Mississippi: The attempt made by the State Plant Board to control the disease by roguing has resulted in failure because of the difficulties in the way of secondary infections. The only hope of control is in immune varieties. (Neal).

Louisiana: The distribution in Louisiana is the same as last year with the exception of reports of the disease from West Feliciana and St. Johns Parishes. The disease has spread so rapidly that it is present in practically all parts of the sugar belt. In the Bayou Teche district which is the last to become infected and which comprises the western portion of the sugar belt, the infection is yet mostly scattering, but in some places as high as 10%. We have no information on the loss caused by this disease though we are convinced that it is not so high as was predicted. There were some excellent yields from fields of nearly 100% infection. (Edgerton).

Porto Rico: Generally prevalent, injuring the crop in very variable proportions. Treatment consisting of elimination through seed selection and eradication has given excellent results. For all practical purposes there is little difference in the resistance of canes here. The Uba is the only immune cane we know. Growers are less concerned about it, because they know they can hold it in check and that its damage to cane is not as great as thought at first. (Matz).

New work by Brandes[1] on sugar cane mosaic in transferring the disease to related plants such as corn and numerous wild grasses is considered very significant in relation to control measures. Comparison also should be made with the reports on corn mosaic in the current Supplement on diseases of cereals, in which the work of Kunkel[2] on a possible causative agent of the mosaic disease of corn is discussed.

Literature cited

1. Brandes, E. W. Artificial and insect transmission of sugar-cane mosaic. Jour. Agr. Res. 19: 131-138. 1920.
2. Kunkel, L. O. A possible causative agent for the mosaic disease of corn. Bul. Exp. Sta. Hawaiian Sugar Plant. Assoc. 3 (1): July 9, 1921.
And Kunkel, L. O. Ameboid bodies associated with Hippeastrum mosaic. Sci. n. s. 55: 73. Jan. 20, 1922.

Fiji disease (cause undetermined)

Interest in this disease has continued. Its known distribution has been increased by the discovery of its presence in another island of the Philippine group. The following letter from H. Atherton Lee, December 6, 1921, is worthy of note:

"We have found Fiji disease distributed in the Island of Negros beyond the possibility of isolation. It has also been found in the Island of Mindanao although we believe that we have entirely eliminated it from that country for the time being. The spread of the disease would indicate that there is some aerial method of transmission of the disease for long distances."

The following references bring the scientific and trade comments on this disease to date:

Anonymous. Mindoro comments on Fiji disease. Sugar Cent. and Plant. News. 2: 127. April 1921.
Ashby, S. F. The Fiji disease of sugar cane. Agr. News. 20: 174-175. May 28, 1921.
Lyon, H. L. Three major cane diseases; mosaic, sereh, and Fiji disease. Bul. Exp. Sta. Hawaiian Sugar Plant. Assn. Bot. Series 3: 1-43. August 1921.
Medalla, M. G. Fiji disease of sugar cane in the Philippine Islands. Phytopath. 11: 251-252. Jan. 1921.

Medalla, M. G. and G. M. Reyes. Fiji disease of sugar cane. Philipp. Farmer 7: 3. Jan. 1921.

Reinking, Otto. Fiji disease of sugar cane. Sugar Centr. and Plant. News 2: 94-102. Mar. 1921.

_____________ A Fiji disease of sugar cane. Sugar Centr. and Plant. News 2: 41. 1921.

_____________ A Fiji disease of sugar cane in the Philippine Islands. Phytopath. 11: 334-337. pl. xv-xvi. Aug. 1921. (Dec.).

Gumming caused by Bacterium vascularum (Cobb) EFS.

Matz reports an increase of 300% in prevalence of this disease in Porto Rico, although the percentage of the crop injured was small. Good results have followed the use of resistant varieties along with eradication of diseased plants. Susceptible varieties are the Otaheite, B. 376, Calaucana, Crystalina, and Rayada. The original area of infection has been extended from 15 kilometers to 50 kilometers at present. A strong campaign of eradication was waged last year and partial success was obtained, but it is difficult to get rid of the disease. There is one kind of cane grown mostly by small farmers, known as Otaheite = Bourbon = Lahaina = Native White, which possesses as much relation to gumming as the rat has to bubonic plague. With out this cane the disease can be eliminated by the use of healthy seed even from such slightly resistant canes as Crystalina and Rayada.

References

Ashby, S. F. Gumming disease of sugar cane in Java. Agr. News 20: 302-303. Sept. 17, 1921.

Matz, Julius. Observaciones en la gomosis de la caña en Puerto Rico. Rev. Agr. Puerto Rico v. 6, no. 4, p. 33-39. Illus. April 1921.

Root disease caused by Plasmodiophora vascularum Matz.

A report from Porto Rico by J. Matz indicates that this disease has greatly increased in prevalence. In this terriotry healthy seed and frequent cultivation are being used as means of combating the disease, it not being known yet whether there are any resistant kinds. The disease has been found very prevalent on the north coast as well as on the south coast. Matz states that:

> "It is the most serious disease of sugar cane here, it actually kills half grown canes producing a dry top rot. There are no striking symptoms, only stunting of cane and failure of crop. I cannot say that the disease is spreading, we simply learn more about its distribution. It has been here for years. It has been found in Barbados according to a communication from J. R. Bovel, Director of Agriculture of Barbados."

The following extract of a letter from Dr. Matz of January,1922 discusses more fully the Barbados situation:

"I wish to call your attention to the fact that Plasmodiophora vascularum has been found this year at Barbados. They received from here a mounted section of infected cane, on a slide, and have soon after discovered the presence of the organism in their canes. This indicates that the disease is present in other countries where sugar cane is grown."

References

Earle, F. S. Sugar cane root disease. Jour. Dept. Agr. Porto Rico. v. 4, no. 1. p. 1-27. Jan. 1920.

Matz, J. A new vascular organism in sugar cane. Jour. Dept. Agr. Porto Rico v. 4, no. 1, p. 41-46. Illus. Jan. 1920.

Downy mildew caused by *Sclerospora sacchari* Miyake

A Sclerospora disease on sugar cane and related grasses has been reported from the Philippines by Lee and Medalla[1] under the name of stripe disease, the organism concerned probably being *Sclerospora sacchari*. The disease was found in April, 1921 in a field of a Formosan variety in Rizal Province, Luzon, which had been introduced by a firm of Japanese growers in 1920. It was not found in fields of native cane nearby. Since *S. philippinensis* has not been inoculated into sugar cane, and has not been found in natural infections in fields of sugar cane near badly infected maize, the evidence is strongly suggestive of the introduction of the sugar cane downy mildew, *S. sacchari*, from Formosa. The infected fields were plowed up, the stubble burned, and the land fallowed, and steps were also taken to trace any seed cane emanating from the affected fields. It is thought possible that the disease may be entirely eradicated in the Islands.

For a discussion of the present situation of sugar cane downy mildew in the Philippines, see the article by W. H. Weston[2]. Reference should also be made to the report of Weston[3] in the Journal of Agricultural Research.

"*Sclerospora spontanea*, the more recently discovered form, occurs in the Islands of Cebu, Bohol, and Leyte, where it was found on the wild grass (*Saccharum spontaneum*) L.), on sugar cane (*Saccharum officiarum* L.), and on maize (*Zea mays* L.). *Sclerospora philippinensis*, the species first recognized, occurs in the Island of Luzon, where it was found on maize, teosinte (*Euchlaena luzurians* Schrad.), and sorghum (*Andropogon sorghum* (L.) Brot.)."

Literature cited

1. Lee, H. A. and M. G. Medalla. Leaf stripe disease of sugar cane in the Philippines. Sci. 54: 274-275. Sept. 23, 1921.
2. Weston, W. H. A note relative to the recent appearance of the sugar cane downy mildew in the Philippines. Phytopath. 11: 371-375. 1921.
3. Weston, W. H. Another conidial Sclerospora of Philippine maize. Jour. Agr. Res. 20: 669-684. Febr. 1, 1921.

New and little known diseases

Philippines: H. Atherton Lee reports several sugar cane diseases of considerable importance:

Sclerotial banded disease reported by Butler in India is very common throughout the Philippines, especially on native varieties. First report.

Leaf spot caused by *Pestalozzia fuscescens* Sorauer var. *sacchari* was found on native varieties in Jolo and Sulu. First report.

Red vascular disease on H 109 cane in Negros, occurring sporadically, similar to a trouble shown by H. L. Lyon at Olaa in Hawaii. It is different from Sereh according to Lyon. In the Philippines there are considerable possibilities of this disease causing damage.

Ring spot caused by *Leptosphaeria sacchari* Breda de H. is common on Negros Purple cane. First report.

Root disease caused by *Aeginetia indica* (flowering plant). Very serious in Laguna and Batangas Provinces. The disease is not apparent until the cane is full grown and does not visibly harm the cane or cause it to appear abnormal, however, the sugar content is reduced to a very small proportion of that of normal cane. This disease should certainly not be allowed to enter into Hawaiian plantations or any other country in the western hemisphere.

Other countries:

Striga root parasite. cases of parasitism by a flowering plant (*Striga densiflora* Benth.) and *Striga euphrasioides* Benth.) on sugar cane and sorghum are described by Luthra, J. C. Striga as a root parasite of sugar cane. Agr. Jour. India 16: 519-523. 1921.

Schizophyllum commune Fr. is reported as a parasite on sugar cane by Vincens, Francois. Parasitisme du *Schizophyllum commune* Fries sur la canne a sucre. Bul. Agr. Inst. Sci. Saigon 3: 65-68. 1921.

Frog hopper blight is reported from Trinidad by C. B. Williams. In this disease the attack by frog hopper is most important, although the loss is aggravated by root disease (Marasmius). (Williams, C. B. Report on the frog hopper blight of sugar cane in Trinidad. Mem. Dept. Agr. Trinidad & Tobago 1: 170. 1921.

Sereh disease of sugar cane is discussed fully by H. L. Lyon and is compared with mosaic and Fiji diseases. (Lyon H. L. Three major cane diseases; mosaic, sereh, and Fiji disease. Bul. Exp. Sta. Hawaiian Sugar Plant. Assn. Bot. Series 3: 1-43. August 1921). In this report it is brought out that its reported occurrence in Hawaii in 1920 by Walter Maxwell was erroneous, the disease in question was probably mosaic but possibly Fiji disease.

Other diseases

Red rot, caused by *Colletotrichum falcatum* Went. was reported as very severe in Florida, the severity being traceable to seed of low quality coming from areas where red rot is prevalent. The first reports were received

February 10 from Bradentown. "During the recent County Agent meeting all agreed that red rot is the worst disease of sugar cane in this state." (Burger). Neal of Mississippi, reports a damage of 5% in a twelve acre field in Pearl River County. Edgerton, in Louisiana, reports moderate amount of the disease which does its damage by reducing the sucrose content. H. A. Lee states that the red rot fungus has been found in Pampanga Province, Philippines, causing leaf injury but never causing red rot of the cane.

Recent literature

Edgerton, C. W. and C. C. Moreland. Fungi and cane germination. Sugar 23: 16-17. Jan. 1921.

Venkatarayan, S. V. Red rot of sugar cane. Mysore Agr. Calendar 1921.

Root rot caused by Marasmius plicatus Wak. and other fungi. Considerable loss from this cause all over the sugar belt in Louisiana was reported by Edgerton. (See also Edgerton, C. W. and C. C. Moreland. Fungi and cane germination. Sugar 23: 16-17. Jan. 1921).

Root rot, caused by Pythium butleri Subramaniam, is reported by Carpenter[1].

"1. The Pythium-like fungus previously reported[2] as an active factor in the root rot disease of cane (Lahaina disease) is morphologically identical with Rheosporangium aphanodermatus Edson and Pythium butleri Subramaniam.

"4. The writer considers that the cane fungus manifests a type of diplanetism in the asexual stage allied to that in the conidium-producing Pythium, and prefers to classify it in the genus Pythium rather than in Edson's new genus Rheosporangium."

Literature cited

1. Carpenter, C. W. Morphological studies of the Pythium-like fungi associated with root rot in Hawaii. Hawaiian Sug. Plant. Assn. Exp. Sta. Bul. 3: 59-65. Aug. 1921.

2. ______________ Preliminary report on root rot in Hawaii. Hawaiian Agr. Exp. Sta. Press Bul. 54.

______________ Pythium in relation to Lahaina disease and pineapple wilt. Hawaiian Plant. Record 23: 142-174. 1920.

Root rot caused by Rhizoctonia grisea, is reported from Porto Rico by Matz. (Matz, J. Investigations of root disease of sugar cane. Jour. Dept. Agr. Porto Rico. 4^1: 28-40. Jan. 1920).

Iliau caused by Gnomonia iliau Lyon was reported by Edgerton as of slight importance in Louisiana this year. It causes a stunting and death of the stalks.

Poor germination of "seed". "A great many different fungi are found on seed cane but the more abundant or more serious ones are Colletotrichum falcatum Went., Melanconium sacchari Massee, Gnomonia iliau Lyon, Marasmius plicatus Wak., Thielaviopsis paradoxa (De Seyn) von Höhn, and species of Fusarium and Scopularia." (Edgerton, C. W. and C. C. Moreland. Fungi and cane germination. Sugar 23: 16-17. Jan. 1921).

Leaf sheath disease caused by Sclerotium rolfsii Sacc. was reported as common in Porto Rico, causing decay of leaf sheaths and adjacent portions of cane stalk of Crystalina cane. (Matz).

DISEASES OF SUGAR BEET

Leaf blight caused by *Cercospora beticola* Sacc.

Leaf blight was in 1920 of slight importance in the majority of beet growing districts of the United States. In 1921 with higher temperatures, earlier season, bright days, and fairly well distributed rainfall at the end of the season, this disease caused grave loss in many of the beet growing sections, especially Michigan and the Arkansas Valley in Colorado. In Michigan the disease is commonly of but slight importance, but in 1921 it reduced tonnage and sugar content below the point of profitable manufacture, according to statements made by agriculturists of the factories, who place the loss at between two and three millions of dollars. (Coons). In the Arkansas Valley of Colorado 80% of the fields were affected and some fields showed between 95 and 100% infection. "This disease is very prevalent in one of the large sugar beet sections. It has caused a heavy loss in this section this year, and the growers are very much concerned about control measures. It has been prevalent for several years, but this year there has been the greatest loss." (Learn). Ohio, Wisconsin, Iowa, and South Dakota report slight losses. Indiana reports the disease as much worse and probably reducing the yield for the state by 1%. (Gardner). The Utah situation presents some interesting features. The disease is known from the Utah and Cache Valleys and was seen on an area about 200 acres in extent, but doing slight damage, however. (Pack).

Curly top (cause undetermined)

Curly top was reported from Utah, Idaho, and Washington, but probably existed throughout its general known range of western states, which coincides with the known range of the sugar beet leaf-hopper, *Eutetix tenella*.

The following reports of disease losses are important:

Utah: Less prevalent than last year, found in 10% of the fields, affecting on an average 1% of the plants and reducing the yield 1%. Known from the Sevier, Sampete, Utah, Salt Lake, and Cache Valleys. First seen in June in Centerfield, but doing its greatest damage in early and mid-summer. (Pack).

See also comment on effect on seed production in Plant Disease Bulletin 5: 139. November 1, 1921.

Idaho: Very important, common in sugar beet sections. "It has become clearly evident this year in several cases that stecklings infected with curly top will not produce any amount of seed. Total loss of seed selections have resulted in some cases." (Hungerford).

More prevalent than last year causing a total loss on 2,697 acres and a 25% loss on 16,783 acres, reducing the yield for the state 12.5%. The geographical distribution is in the Lower Snake River Valley, especially around Twin Falls, Burley, and Minidoka. First seen in May at Filer. (Pack).

Washington: Crop loss on sugar beets estimated at 3%. (Heald and Dana).

California Some promising types of sugar beets resistant to curly top are being grown at isolated places throughout Riverside County.

Comparison of known distribution of the curly top leaf-hopper and curly top, as shown by E. D. Ball in Utah Station Bulletin 155, makes it very evident that distributional studies of both insect and the disease should be vigorously pushed, along with intensive study of factors governing regional distribution, in order that adequate protection may be given other beet areas. Dr. Ball also calls attention to the possibility of cycles of the insect and waves of disease. "I would like to call your attention to page 34 (loc. cit.) for a time distribution of attacks which very strongly suggests that the four-year troubles that they have been having in California and the western country generally are another cycle of increase which will be rapidly followed by a decrease."

"From all information that I have, there has been no extension of distribution recorded except that the leaf-hopper has been seen in one place on the alkali plants on the shores of western Florida, probably a drift from Texas. (E. D. Ball).

Root rots

Root rot caused by Phoma betae (Oud.) Frank. This disease was reported as producing either no loss or very slight loss in Indiana, Wisconsin, Colorado, and Washington. In several other states loss was important.

Utah: More severe than last year, causing a reduction in yield to the state of 8%. Blighting of the top (leaves) and finally a root rot occurs. Was present throughout the state, but especially severe in Cache and Box Elder Counties. First recorded July 8 at Logan. The estimate of loss is not based upon definite data gathered from the entire state, but from studies made primarily in Cache and Box Elder Counties. Allowances were made for the small amount of disease in other beet growing districts. Twenty percent loss probably occurred in Cache County. (Richards). (See also Plant Disease Bulletin 5: 140, Nov. 1, 1921).

Idaho: More prevalent than last year, being important in southeastern Idaho around Bear Lake, Minidoka, Twin Falls, and Madison Counties. (Raeder).

Michigan: Root rot and leaf spot are becoming more manifest in this territory each year, the percent of loss depending on the weather conditions. The crop in this immediate territory this past year yielded only six tons to the acre as compared with a ten-year average of ten tons per acre. Of this 40% loss in tonnage, I attribute 25% to root rot. I base this on counts of thousands of plants that I made in representative commercial fields. This direct tonnage loss was increased 15% by leaf spot which defoliated many of the plants which resisted many of the attacks of root rot.

The fact that the average sugar content of all the beets in this territory has also been greatly reduced is, in my judgment, largely due to both the above diseases. The average sugar content

of the cossettes of the Blissfield Plant is 13%, as compared to 15% for a ten-year average.

I am unable to determine the percentage of this sugar content loss which is attributed to each of the diseases under discussion. Both the diseases retard the normal functioning of the plant. The leaf spot, by defoliating the plants, retards the storage of sugar and depletes the amount previously stored in growing new leaves. Root rot entirely destroys a large percentage of the beets and many of the plants that do survive the disease have malformed roots incapable of the storage of a normal amount of sugar. Another factor of loss in root rot is the fact that in many cases the entire planting is lost, requiring replanting, even the second and third planting resulting in the entire loss of the crop or a diminished stand. The diminished stand, the extra amount of seed required for replanting, the additional cost of labor in refitting the ground, the diminished yield caused by the late planting occasioned by the loss of the previous planting, are all factors of loss. (Letter to Dr. C. O. Townsend, Sugar Plant Investigations, from W. H. Burns, Agriculturist, Sugar Plant Investigations, Blissfield, Michigan, January 17, 1922).

Rhizoctonia rot (other organisms may be associated) caused considerable loss in Indiana (Gardner), 10-25% loss in some Michigan fields (Coons), sometimes common and destructive in Iowa (Melhus), rather serious in Cache County, Utah, but less than in 1920, producing dry rot canker; known for Cache, Davis, and Webber Counties, but first seen July 15 at Cornish. (Richards), slight damage also reported by D. A. Pack from the Bear River Valley, Utah.

Root rot (undetermined). Root rot taking the form of damping-off or a rotting of the main root with half grown beets was reported as very serious in Indiana, Michigan, Wisconsin, Utah, and Idaho. Heavy rains at time of thinning operation and before seem associated in Indiana where the loss for the state is estimated at 5%. First seen June 1 in Allen County. Fort Wayne records show that it rained May 23, 24, 25, 26, 27, 28, 31, June 2, and 3. (Gardner).

Michigan: Poor stand common in many sections where beets semingly outgrew primary damping-off. Flagging occurred in July and August due to blackened tap root and inability to stand drouth conditions. Trouble was seen to be much worse where beets followed beets or clover and of minor importance where beets followed corn. (Coons).

Wisconsin: Stand of beets only fair. (Bureau of Crop Estimates Crop Notes, week ending June 25).

Utah: Root rot of unknown cause was much more severe than last year. Twenty-six percent of the Cache Valley acreage was infested, causing a loss of approximately 86,000 tons of beets and a reduction in yield for the state of over 6%. The spring was wet (2.8 inches above normal) with summer and fall temperatures down. (Pack).

Idaho: Much more severe, reducing the yield in the state 12%. First seen in August at Sugar City. Spring moisture was .38 of an inch above normal; summer and fall were dry. Both spring, summer and fall were much higher than normal. (Pack). (See also Plant Disease Bulletin 5: 139. November 1, 1921).

Alternaria root rot was reported as extremely prevalent in the Arkansas Valley and in Utah, attacking in August, but doing its greatest damage in September. (J. G. Lill and D. A. Pack).

Other diseases

Rust caused by *Uromyces betae* (Pers.) Tul. was reported from California by Milbrath as doing slight injury.

A disease which reduced the leaf surface, stunted the roots, and caused premature death everywhere in Indiana was first seen August 5 at Decatur. This appears to be the same trouble described by Cunningham in 1899 in the Botanical Gazette as a bacterial disease. Specimens sent to Carsner and the trouble was pronounced not to be curly top. (Gardner).

Root knot caused by *Heterodera radicicola* (Greef) Müll. was reported by Milbrath of California as follows: "Throughout the state the loss can be estimated at 8% as an average. The range of loss extended from a trace to 75%, in individual fields." Gerald Thorne of Utah reports as follows: "Quite general in Davis County where 125 fields were infested. The total number in the state was probably not less than 200. Injury ranges from very slight to 50% of the crop in some small fields. Known for Salt Lake, Cache, Utah, Box Elder, Webber, and Davis Counties."

Nematode injury caused by *Heterodera schachtii* Schmidt has infested many of the principal beet growing sections of Europe causing severe losses. First found in western United States about 15 years ago. Since that time found in many of the principal beet growing sections of Utah, Idaho, California, and Colorado. As a result of survey of the Office of Sugar Plant Investigations, it is found that infestation is spreading rapidly and is becoming a serious menace to the sugar beet industry in some localities. (See Fig. 84). At present only about one-twentieth of the sugar beet acreage in the United States has been inspected and it is probable that many additional fields will be found when careful inspection is made. The following summary of sugar beet acreage surveyed gives the present status:

Table 98. Present status of the sugar beet acreage surveyed.

State	Total acreage surveyed	Acreage infested
Utah	24,473	3,238
Idaho	2,096	515
Colorado	7,160	899
California	18,945	2,535
Total	52,674	7,187

In figuring the infested acreage, the total areas of infested fields are given. Since the actual infested areas vary from a few square rods to

the entire field, it will be conservative to figure the actual affected area as 25% or 1,795 acres. The average loss because of the infestation will be not less than six tons of beets per acre or 10, 662 tons. Valued at $12.00 a ton, the cash loss to the growers alone was $129,000. This was the loss in only the areas surveyed and it is very doubtful if more than two-thirds of the infested areas are included in these surveys. Many areas are known to be infested in which no work has yet been done. (Gerald Thorne and L. A. Giddings).

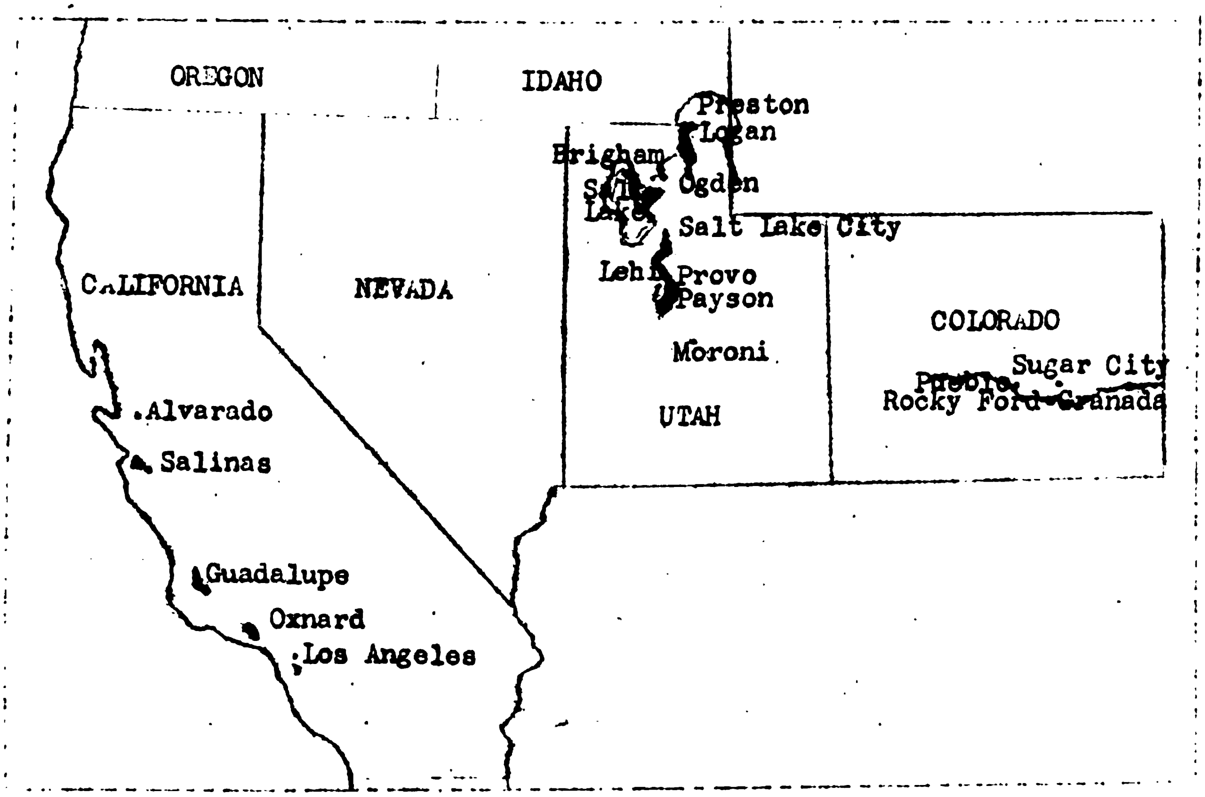

Fig. 84. Distribution of the sugar beet nematode in western United States. (After map by Thorne, Gerald and L. A. Giddings, Farmers' Bulletin 1248: 4. Feb. 1922).

Utah: Found in Cache, Box Elder, Webber, Davis, Salt Lake, Utah, and Sampete Counties. Actual infested acreage is placed at 600, of which about three-fourths has been surveyed, the remainder estimated. The area of fields infested in the state, part of which are under crop rotation is 4,395 with an actual infestation area in the state at approximately 1,100 acres. (Gerald Thorne).

Colorado: Found in the Arkansas Valley, Pueblo, and Rocky Ford. In the Pueblo district 20% of the fields are infested. There are scattering fields in other districts. The disease is known in 470 acres, reducing the yield on an average 3,820 tons. (Charles Price).

<u>California</u>: Infested areas are on the increase. About 7% loss can be estimated for the state, ranging per field from a trace to 20%. (Milbrath).

The following German summary of control measures may be cited: Müller, H. C. and E. Molz. Versuche zur Ermittlung des Wirkungswertes verschiedener Stoffe zur Bekämpfung der Rübennematoden in Schlammerdam. Blätt. Zuckerrübenb. 28: 96-102, 144-149. May, July 1921. no. 9/10, 13/14.

<u>Nematode</u> - <u>Tylenchus penetrans</u> Cobb was found in a small area near Ogden, Utah; damage slight. (Gerald Thorne).

TOBACCO

Wildfire caused by <u>Bacterium tabacum</u> Wolf and Foster

Wildfire was reported by Lutman as serious in the Connecticut Valley, Vermont. It was more prevalent than formerly in Massachusetts where it did slight damage, being spread rapidly by hard rains. (C. M. Slagg). In Connecticut the disease was also more prevalent and may cause serious loss due to depreciation of market values. The disease was found in Hartford and Toland Counties, first appearing in May. (See notes by Clinton, Plant Disease Bulletin 5: 19, July 1, 1921). In Pennsylvania, according to Thurston and Orton, the disease was serious, causing a loss of 10%, being first found in Lancaster County, May 28, 1921. (For data as to distribution in Pennsylvania, see Plant Disease Survey Bulletin 5: 37, and 5: 88, 1921). It was reported by J. E. McMurtrey as doing considerable damage in Maryland (Prince Georges and Calvert Counties); by Fromme as doing slight damage in Virginia (.5%). Valleau reports the disease as not serious in Kentucky (See Plant Disease Bulletin 5: 19, 1921). Sherbakoff in Tennessee reports that tobacco was affected with wildfire, but less than during the preceding season. "We are now recommending seed treatment with formaldehyde 1 to 16 for 15 minutes with subsequent washing, without which the treatment with us is not safe." Other states reported as follows: North Carolina, slight; South Carolina, important locally; Ohio, definite report of occurrence made by Clayton; Wisconsin, no wildfire occurs in commercial fields. (James Johnson).

Union of South Africa: The following report appears in the Journal of the Department of Agriculture of South Africa 2: 310, April 1921. "The bacterial disease of tobacco previously recorded ..... is spreading rapidly. So far as investigation has gone, it bears a very strong resemblance to the wildfire of tobacco reported from the United States."

Studies by Slagg (Slagg, C. M. Preliminary report on a study of the wildfire disease of tobacco. (Abstract) Phytopath. 12: 51-52. Jan. 1922) indicate that there is some variation among the organisms responsible for this condition.

Angular spot caused by <u>Bacterium angulatum</u> Fromme and Murray

This disease was known previously from Virginia, Kentucky, and Tennessee, and its presence was suspected in Ohio. In 1921 it was reported as not being

seen in Massachusetts, Connecticut, and Pennsylvania, and undistinguished in Maryland. Positive reports from North Carolina and Indiana where it was reported as being serious locally extend the range for the United States. The following statement by H. W. Taylor of the Board of Agriculture of Rhodesia, South Africa is of interest:

> "Wildfire and angular spot occur in Rhodesia and were no doubt introduced from the use of tobacco seed imported from the United States. The angular spot has been very prevalent during the past two seasons and has caused severe loss to many tobacco growers. The Department of Agriculture is prepared this year to treat tobacco seed free for farmers in southern Rhodesia."

<u>Kentucky</u>: Widespread, but not causing so serious a loss as in 1920, on account of the dry season. In a few places there has been considerable infection following heavy rains with wind. (Valleau).

<u>Virginia</u>: Loss, slight to moderate this year, reducing the yield of the state 5%. Infection was general, but held in check by dry weather. Seed treatment coupled with proper plant bed sanitation gave excellent results. (Fromme). (See Fromme, F. D. and S. A. Wingard. Treatment of tobacco and suggested program for control of wildfire and angular spot. (Abstract) Phytopath. 11: 48-49. 1920).

Root rot caused by <u>Thielavia</u> <u>basicola</u> (B. & Br.) Zopf.

This root rot was generally reported as prevalent in tobacco sections, but all collaborators agree that the disease was much less severe than in 1920. The following estimates of loss were reported: Massachusetts 3%, Connecticut 5%, Pennsylvania 5%, and Wisconsin 1%.

<u>Varieties vary in resistance</u>

Cuban (shade) is more resistant in Massachusetts than Havana (air grown) seed, according to Slagg. Clinton reported that Round Tip is rather exempt in Connecticut. The Connecticut varieties stand as follows in resistance: first, Connecticut Round Tip; second, Shade Cuban; third, Broadleaf; and fourth, Havana. Tests of five resistant strains are being carried on in Kentucky. Selby reports marked resistance of the new Montgomery Seedling variety in Ohio where one or two Spanish sorts were also resistant, while a test of the root rot resistant strain received from Wisconsin showed serious infection. James Johnson states that in Wisconsin marked differences in resistance of strains are evident and that resistant strains are being used commercially on about 3,000 acres in that state.

Mosaic (cause unknown)

Mosaic was reported from Massachusetts, Connecticut, Pennsylvania, Maryland, Virginia, Kentucky, North Carolina, South Carolina, Ohio, Wisconsin, and Hawaii. No state reported more than 2% damage. For comments by collaborators, see Plant Disease Bulletin 5: 106-107. 1921.

Experimental work by Johnson (Johnson, James. Experimental evidence relating to the nature of the mosaic virus. (Abstract) Phytopath. 12: 52. Jan. 1922) has shown that the optimum temperature for mosaic disease of tobacco lies close to 28-30°C. with a maximum of approximately 37°C.

Downy mildew caused by _Peronospora hyoscyami_ de Bary

In 1921 downy mildew (also called "blue mold") of tobacco appeared in the United States for the first time. According to Smith and McKenny[1] of the Federal Department of Agriculture, it was first observed about March 21 in seed beds in Gadsden County, Florida, and during the rest of March and the first part of April it spread rapidly throughout Gadsden County and the adjoining Decatur County, Georgia. It aroused great apprehension among the growers, who believed they were threatened with the complete loss of their crop; but the hot dry weather which prevailed after the middle of April and during May, checked its progress so that the total loss in the affected district probably did not exceed 5%.[2]

According to O. F. Burger, the disease was confined to the sand leaves and was favored by the cool weather of April, but later checked by warm dry weather.

The following publications have appeared recently on this disease:

1. Smith, E. F. and R. E. B. McKenney. A dangerous tobacco disease appears in the United States. U. S. Dept. Agr. Cir. 174. April 1921.
2. ______________________ The present status of the tobacco blue mold (Peronospora) disease in the Georgia-Florida district. U. S. Dept. Agr. Cir. 181: 3-4. 1921.

Burger, O. F. and H. C. Parkham. Peronospora disease of tobacco. Florida State Plant Bd. Quart. Bul. 5: 163-167. July 1921.

Palm, B. T. The false mildew of tobacco introduced into the United States from the Dutch East Indies. Phytopath 11: 430-432. 1921.

Smith, E. F. and R. E. B. McKenney. Suggestions to growers for treatment of tobacco blue mold disease in the Georgia-Florida district. U. S. Dept. Agr. Cir. 176: 2-4. 1921.

Wilt caused by _Bacterium solanacearum_ EFS.

Virginia: More prevalent than in 1920, being reported from Patrick, Pittsylvania, Charlotte, and Mecklenburg Counties, reducing the yield for the state .5%. Its unusual prevalence probably associated with hot, dry season. (Fromme).

North Carolina: Most destructive of the tobacco diseases, land often being abandoned because of its infestation with the wilt organism. Common this year on land grown to tobacco for years, especially in Granville, Vance, Durham, and Wake Counties. (Foster).

Other diseases

Leaf spot caused by Cercospora sp. was reported by H. Atherton Lee as doing slight injury in the Philippines. There are localities in the northern province of Luzon where leaves affected with Cercospora bring a higher price than normal leaves. This is due to a confusion of these leaf spots with what is known as "batec". This batec seems to be due to some sunburn injury or possibly some varietal characteristics. Such batec leaves are said to have a better flavor.

Kunkel reports that a leaf spot, probably caused by Cercospora was found at South Koua, Hawaii.

Damping-off caused by various fungi. Damping-off by Rhizoctonia and by Sclerotinia libertiana were reported from Connecticut. Pythium debaryanum caused damping-off in Pennsylvania and Connecticut. Wisconsin reports damping-off as widespread but of slight importance.

Wilt caused by Fusarium oxysporum nicotianae Johnson. Found first near Benedict, Charles County, Maryland in 1916 and in 1917 on other farms, while in 1919 it was received from Owensville, Ohio on mature plants of White Burley. It is believed that Fusarium wilt is not a serious disease, and will probably never become of great economic importance; if, however, it becomes more generally introduced into the White Burley districts it may become a serious parasite. (Johnson, James. Fusarium wilt of tobacco. Jour. Agr. Res. 20: 527-535. 1921).

Streak. A disease resembling streak of potato was noted by Kunkel at South Koua, Hawaii.

Hollow stalk (bacterial) was reported from Massachusetts and Connecticut as of minor importance.

"Black rot". Some black rot occurred during the fermentation of the 1920 crop, one warehouse reporting a very considerable loss running into several thousand dollars. (J. Johnson).

Fusarium leaf spot was reported as producing inconspicuous injury on weak plants in the seedbed and occasionally found on shade leaves in the field. (Clinton).

Injury to tobacco from fertilizer was reported from Connecticut and North Carolina.

Drouth spotting was reported from Connecticut and Ohio.

White speck was important on the Broadleaf variety in Connecticut.

Potash hunger, showing itself by the production of yellow spots on the leaves and by dwarfing, was reported from Virginia.

"Rust" was reported as doing slight damage from practically all the tobacco sections. This is the general term, having no specific meaning, but in 1921 the most prevalent type was the dying after severe mosaic attacks. This was reported from Wisconsin and Connecticut.

Non-parasitic spots of different types were reported from Massachusetts, Connecticut, and Wisconsin. A discussion of this type of breakdown was given by Johnson at the Toronto meeting. (Johnson, James. Non-parasitic leaf spots of tobacco. (Abstract) Phytopath. 12: 52. Jan. 1922).

DISEASES OF MISCELLANEOUS VEGETABLE CROPS

ARTICHOKE

Southern blight of Jerusalem artichokes, Sclerotium rolfsii Sacc. - South Carolina, unimportant.

Wilt, Sclerotinia spp. - Washington.

ASPARAGUS

Rust caused by Puccinia asparagi DC. was reported from Vermont, New York, Pennsylvania, Texas, Iowa, North Dakota, Colorado, and Washington as present and doing slight damage, and from Michigan and Minnesota as more prevalent than during the previous years. The result of a questionnaire concerning the prevalence of rust and the use of resistant varieties has been summarized in the Plant Disease Bulletin 5: 120-121, which should be consulted by those interested.

It is evident from the tone of the replies to the questionnaire that in the majority of the localities the asparagus rust situation is of minor importance and that in those areas where the culture is intensive the use of resistant or semi-resistant varieties is giving good satisfaction. It is extremely important that further attention be given this crop and that observations on the various strains, especially the Washington varieties, should be continued. The seed of these varieties was originally distributed by the Office of Cotton, Truck, and Forage Crop Disease Investigations to experiment stations, seedsmen, and individuals in the various states, and sources of seed and roots should be located in order that the promising advance made by the development of these varieties be not lost.

Root rot caused by Fusarium spp. Dying out of roots over circular areas, a disease in which the plants were stunted, became brown, and finally died, was reported by Cook at the Toronto meeting. (Cook, Mel T. A new disease of asparagus. (Abstract) Phytopath. 12: 49. 1922) as a "new" disease. He stated, however, that since his observation was made it has come to his attention that Halstead had previously described this disease. In the questionnaire on asparagus rust several collaborators (Massachusetts, New York, Illinois) included a report that a root and crown rot due to Fusarium had been noticed and was causing greater loss than rust. The disease is evidently widespread and of considerable importance. What may be the same type of trouble in California is referred to by Milbrath: "At Sacramento I found considerable 'rusty' lesions on asparagus shoots, sometimes attributed to Fusarium sp."

Rhizoctonia rot following frost injury was reported from Michigan.

BEET (Garden)

Scab caused by Actinomyces scabies (Thax.) Güssow was unimportant in New York, New Jersey, Ohio, and Idaho.

Leaf spot caused by Cercospora beticola Sacc. was of slight importance in New Jersey, Ohio, Minnesota, and North Dakota; in Texas, very prevalent, 5% loss; in Indiana very serious factor in market gardens, causing a loss of 1%; and in Illinois the most important beet disease.

Root knot caused by Heterodera radicicola (Greef) Mill. caused 1% loss in Texas.

Damping-off caused by Pythium debaryanum Hesse caused slight injury in seedbeds at Westville, Connecticut.

CARROT

Watery soft rot caused by Sclerotinia libertiana Fckl. was reported by food-products inspectors of the Bureau of Markets and Crop Estimates as occurring in carloads of carrots originating in Louisiana, Mississippi, New York, South Carolina, and Texas.

Rhizopus rot caused by Rhizopus sp. was reported by market inspectors as causing slight decay in carloads of carrots from Indiana, New York, South Carolina, and Texas.

Leaf spot caused by Cercospora apii carotae Pass. was reported from Pennsylvania, and from Indiana as worse than last year in market gardens, being very destructive to foliage, especially under overhead irrigation. It was first reported July 12 from Marion County. (See also Murata, Jutaro. Leaf blight of carrot and its control. I. Jour. Plant Prot. 8: 185-188. April 1921 (Japanese), and Leaf blight of carrot and its control. II. Jour. Plant Prot. 8: 233-236. May 1921).

Decay caused by Alternaria sp. (See Meier, Fred, Chas. Drechsler, and Emery Eddy. Storage rot of carrots caused by a new species of Alternaria. (Abstract) Phytopath. 12: 49. 1922).

Root knot caused by Heterodera radicicola (Greef) Mill. was reported from Ohio and Washington.

Rhizoctonia rot caused by Rhizoctonia crocorum DC. Western Washington: The violet Rhizoctonia is also found commonly on the common carrot in affected districts where it also is common on potatoes. (Frank).

CASTOR BEAN

Bacterial wilt caused by Bacterium solanacearum EFS, according to Smith and Godfrey, was found on castor beans at several points in Florida, one place in Georgia, and one in Alabama; and from reports of farmers it very likely occurs in North and South Carolina and Mississippi also. The disease was not found on the east coast of Florida, although thorough search was made. The soil on the east coast contains an abundance of lime. Newer land is more likely to show the wilt than land that has been under cultivation longer. Losses up to 10%, exceptionally over 10%, occur. The highest loss observed was 30% in a field in Georgia. (Smith, Erwin F. and G. H. Godfrey. Bacterial wilt of castor bean (Ricinus communis L.). Jour. Agr. Res. 21: 255-261. May 16, 1921).

Texas root rot caused by Ozonium omnivorum Shear was very prevalent in Texas, causing a reduction in yield of 25%.

CELERY

Yellows caused by Fusarium sp.

This disease is to the celery crop what cabbage yellows is to cabbage. It was first studied in Michigan, but evidently very widespread in the north-

eastern celery growing districts, being reported by Coons and Nelson[1] as known from New Jersey, Indiana, Massachusetts, and Connecticut. Reports to the Plant Disease Survey for the 1921 season show the disease to be present in Indiana, Michigan, Minnesota, and Colorado (specimens from each locality examined by Nelson and Coons). The report from Indiana states that the disease was less serious than in the previous year but was a limiting factor with the Golden Self-blanching variety. Gardner reports that growers at Goshen, Indiana have substituted Easy Blanching and that no yellows could be found September 22, although in that same district 100% soil infestation has been present since 1914. The Michigan report states that there was a complete loss of Golden Self-blanching, and even of Easy Blanching, in some soils due to the very high soil temperature. "This is a soil sickness and rapidly becomes a 100% infestation. Loss is lessened by use of the green variety 'Easy Blanching'. Annual loss from failure of Golden Self-blanching and from the use of a variety of less market value can conservatively be placed at $2,000,000." (Coons and Nelson). Minnesota reports the first occurrence of this disease in Ramsey County where it caused a severe stunting of a large percentage of plants. Learn of Colorado reports an unknown yellowing of plants as quite common about Denver, which in view of specimens received from the same locality and diagnosed by Coons may fairly safely be attributed to Fusarium.

Report of progress in developing yellows-resistant seed of Golden Self-blanching celery is made by Coons and Nelson[2]. A report of the Minnesota occurrence of the disease is made by R. C. Rose[3]. (See also Plant Disease Bulletin 5: 148-151. 1921).

<u>References cited</u>

1. Coons, G. H. and Ray Nelson. Celery yellows. (Abstract) Phytopath. 11: 54-55. 1921.
2. ______________ First progress report on "yellows" resistant Golden Self-blanching celery. (Abstract) Phytopath. 12: 48. 1922.
3. Rose, R. C. Two destructive plant diseases. Minn. Hort. 49: 333-334. Dec. 1921.

Late blight caused by *Septoria apii* (Br. & Cav.) Chester

Celery late blight was reported from Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Ohio, Michigan, North Dakota, Washington, and California. In general, in those states raising early crop celery, blight was severe where July and August rains were frequent. New Jersey reports the disease as abundant and causing heavy loss. Delaware reports a reduction in yield of 5%. The greatest loss was reported from Michigan where a loss of 25 to 50% of the late crop was brought about by the heavy and well distributed September rainfall. The report from California stated that in the 1920-21 crop in the El Monte district there was a loss of 15% and in the Watsonville district one of 20%. Milbrath comments further that the disease was unusually severe in these sections due to cessation of spraying on account of market conditions. In the San Diego district there was considerable infection which was kept under control by continuous spraying. Cook of New Jersey states that spraying with Bordeaux mixture 5-6-50 was effective. Thurston and Orton report good control in Luzerne County, Pennsylvania by spraying. Adams of Delaware states that Bordeaux dust and liquid Bordeaux have proved

equally successful in the control of late blight in demonstration work. Coons reports spraying at Portage and at Muskegon, Michigan, using Bordeaux mixture, entirely successful.

The following special reports on the results of spraying and dusting for the control of this disease are of interest:

<u>New York</u>: Celery blights were less destructive than usual, because of extremely dry weather. The following are some of the results of the control of blight through spraying and dusting.

The average of a total of six experiments over a period of three years showed after five applications of 5-5-50 Bordeaux mixture that the average check has 1079 blight spots per plant ranging from a minimum in any experiment of 507 spots per plant to a maximum of 1733. Sprayed plants showed 63 blight spots per plant on the average and the minimum was 35, while the maximum number of spots was 126.

Power spray and dust plots this season showed the following differences: Six applications of 5-5-50 Bordeaux gave a reduction in blight of 91%, while the six applications of equivalent amounts of 15-85 copper lime dust (containing 15% monohydrous copper sulphate and 85% lime) gave a reduction of 95% in the development of blight. The spray gave an increase of 46 two-thirds size crates per acre, while the dust applications gave an increase of 70 of these crates per acre. (H. W. Dye, January 28, 1922. See also Dye, H. W. and A. G. Newhall, l. c. under bacterial leaf spot).

<u>Ontario</u>: We have been using for the past two years a dust made up of 20% Bordeaux, 20% sulphur, 30% lime, and 30% tobacco dust. We use the combination of sulphur and Bordeaux for two reasons; one that it seems as if the sulphur made the Bordeaux stick better and also seemed to aid in controlling the late blight. The tobacco dust was added to get control of the tarnished plant bug which has caused us a great deal of loss through the disease locally called celery heart rot; this disease is secondary. We found during the past two years that the tobacco dust was much more satisfactory in warding off this insect than the "Black Leaf 40" because it holds its odor much longer. It is necessary to dust each week; where this is carried on thoroughly we found we had no difficulty in controlling both the disease and the tarnished plant bug. (A. H. MacLennan, Vegetable Specialist, Department of Agriculture, Ontario).

<u>Recent literature</u>

Laibach, Friedrich. Untersuchungen über einige Septoria-arten und ihre Fahigkeit zur Bildung höherer Fruchtformen III und IV. Zeitschr. Pflanzenkr. 31: 161-194. 1921.

Early blight caused by <u>Cercospora apii</u> Fries

Early blight of celery was reported from Vermont, Rhode Island, Connecticut, New York, Pennsylvania, South Carolina, Ohio, North Dakota, Colorado,

and California as being either unimportant or of about the same prevalence as last year, while in New Jersey, Delaware, West Virginia, Florida, and Indiana it was said to be abundant and causing heavy losses. In Indiana, according to Gardner, it was probably the worst disease of the crop.

Bacterial leaf spot caused by Bacterium apii Jagger

This disease, first mentionod by Jagger some years ago in a short note, was described by him during 1921 as due to a new bacterium. The distribution, as given by records available to Jagger, was New York and Michigan, but doubtless the disease is present throughout the northeastern celery growing district. It is reported in 1921 as being of about the normal prevalence in New York, reducing the yield 2 to 5%. Newhall reports green stem types less affected than Easy Blanching. The disease is reported as doing perhaps more than the usual amount of injury in Michigan. Interesting results in the matter of control with the use of equivalent amounts of 5-5-50 Bordeaux mixture and 15-85 copper lime dust were reported by Dye and Newhall[1]: "Almost complete reduction of blight development was obtained. The spray and dust appeared to be equally effective in controlling these blights, and both gave similar increases in yields over the checks." (See also the special report by Dye on spraying and dusting celery under late blight).

Literature cited

1. Dye, H. W. and A. G. Newhall. Spraying and dusting for the bacterial and late blights of celery in western New York. (Abstracts) Phytopath. 12: 48. 1922.
2. Jagger, Ivan C. Bacterial leaf spot disease of celery. Jour. Agr. Res. 21: 185-188. 1921.

Other diseases

Bacterial soft rot caused by Bacillus carotovorus Jones - New Jersey (root rot, very destructive, especially on muck soils. Poole, R. F. Celery disease investigations. Rep. Dept. Plant Path. New Jersey Agr. Col. Exp. Sta. 1919-20. 608-609), Pennsylvania, and Ohio.

Black heart, cause unknown, caused heavy loss at Sanford, Florida. (Jagger, March 9, News Letter, Office of Cotton, Truck, and Forage Crop Disease Investigations, May 7).

Watery soft rot caused by Sclerotinia libertiana Fckl. was locally severe in New York, New Jersey, Florida, and California, causing field and storage rot in New York; damping-off in greenhouse seedbeds in New Jersey; foot rot in Florida (Jagger); and in Los Angeles, Orange, and Santa Cruz Counties, California, reducing the yield 3%.

Rhizoctonia rot - Connecticut (fruiting at base of stalks), New York (stalk discoloration), Ohio (root rot and general decay in the trenches).

Damping-off - Connecticut (Pythium debaryanum Hesse), California (Fusarium sp.; about 5% loss in the El Monte district - Milbrath).

Root rot, cause unknown, was observed in Erie County, New York, August 23.

Suspected mosaic was reported from Indiana on Golden Self-blanching.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported from South Carolina and Indiana.

Crinkle, cause unknown, was of slight importance in Connecticut.

Hollow stem was common throughout the state of California, causing stalks to collapse and decay rapidly. (Milbrath).

Annualism, "Seeders", was very prevalent in western Washington.

EGGPLANT

Fruit rot caused by *Phomopsis vexans* (Sacc. and Syd.) Harter - severe in New York (5% loss), New Jersey, Maryland (5% loss), Virginia (50% loss at Truck Station, Norfolk), West Virginia (5% loss), Tennessee (common), Illinois (most serious disease of eggplant), and Michigan (100% loss in some fields, but negligible because of no market for eggplants). One report was received in Ohio, and Iowa reported it as less prevalent than last year. The high losses in the northern states doubtless were related to the high temperature.

Market inspectors reported fruit rot as causing an average of 22% loss in ten cars of Florida eggplants and 5% in one car from Texas.

A leaf spot caused by *Alternaria* sp. was general but slight in West Virginia.

Mosaic - (See Melhus, I. E. Mosaic studies. (Abstract) Phytopath. 12: 42. Jan. 1922).

Bacterial wilt caused by *Bacterium solanacearum* EFS was reported from Pennsylvania and Virginia. At Freeland, Pennsylvania Weiss reported it as causing 100% infection and serious injury on Chinese white eggplant. In Virginia it first appeared July 25 at Oceana where it was very severe in a home garden.

Wilt caused by *Verticillium albo-atrum* Reinke and Berth. was reported by Cook as being abundant in New Jersey.

Wilt caused by *Fusarium* sp. (?) was reported as first appearing September 8 in Westchester County, New York.

Rhizoctonia sp. was reported from Freeland, Pennsylvania by Weiss.

Wilt of unknown cause (a Sclerotium isolated) was reported by Gardner as being the worst disease of the crop in Indiana, causing premature death of the plants.

Damping-off caused by *Pythium debaryanum* Hesse and *Rhizoctonia* sp. was reported by Clinton as occurring in seedbeds at Highwood, Connecticut April 11, and at Westville April 13.

Stem rot and blight caused by Nectria sp. (See Ishikawa, Takitaro. Nosu to Sekkwai Iwô Gôzai. (Lime sulphur and eggplant). Jour. Plant Prot. 8: 177-185. April 21).

Rot caused by *Phytophthora* sp. occurred in one garden in Lafayette, Indiana in September; probably spread from tomatoes to eggplant. Artificial inoculation successful. (Kendrick). (See also Haskell, R. J. Phytophthora infestans on eggplant in the United States. Phytopath. 11: 504-505. 1921).

Nematode, presumably *Heterodera radicicola* (Greef) Müll. was extremely severe at Freeland, Pennsylvania, according to Weiss.

Storm injury, Burger reports a hard wind storm (October 23-25) in Florida which did considerable damage to the crops of the state, and caused almost total loss to eggplants in Manatee County.

ENDIVE

Damping-off caused by Rhizoctonia solani Kühn was slight in seedbeds at Westville, Connecticut, April 13.

Root rot caused by Pythium debaryanum Hesse was slight in greenhouses at New Haven, Connecticut, June 17.

GINSENG

Root rot caused by Phytophthora cactorum (Leb. and Cohn) Schröt. - Connecticut (rot of the roots and stem; first appeared June 24 at Winsted; first report for state).

A root rot, cause undetermined, - Washington.

Blight caused by Alternaria panax Whetzel - Michigan.

Moldy seed caused by Botrytis sp. - Washington.

Reference: Stockberger, W. W. Ginseng culture. U. S. Dept. Agr. Farmers' Bul. 184. April 1921.

LETTUCE

Drop, caused by Sclerotinia libertiana Fckl. or S. minor Jagger was reported as common in many states, with occasional reports made of some loss occurring locally. The following states reported the disease: Connecticut (at Ellington, October 3), New York (1 to 3% loss), New Jersey (common), Pennsylvania (40% loss in one greenhouse, 10% loss in one field), Maryland (trace), North Carolina (less), South Carolina (little damage in fields - Jagger), Texas (unimportant), Ohio (moderate loss), Minnesota (serious where rotation is not practiced, but less in 1921 because of heat destroying the crop - Leach), California (3% loss, found in Los Angeles, Santa Cruz, and Orange Counties).

Gray mold rot caused by Botrytis cinerea Pers. - slight damage in Connecticut, New York, Maryland, Ohio, Indiana, and Iowa.

Downy mildew caused by Bremia lactucae Regel - unimportant in New York, Texas, Washington; locally serious in Indiana (greenhouse), Iowa, Kansas (caused about 75% loss of seedlings in propagating houses of one grower); very important in California (reducing yield 5%; found in southern California, except Imperial Valley).

Recent literature

Erwin, A. T. Control of downy mildew of lettuce. Proc. Amer. Soc. Hort. Sci. 17 (1920): 161-168. 1921.

__________ Controlling downy mildew of lettuce. Iowa Agr. Exp. Sta. Bul. 196: 307-328. Illus. Jan. 1921.

Link, Geo. K. K. Downy mildew; a transit disease of lettuce. (Abstract) Phytopath. 12: 48-49. Jan. 1922.

Anthracnose caused by Marssonia panattoniana (Berl.) Magnus - Kansas (33% loss at Hutchinson), Washington (Whitman County).

Leaf spot caused by Septoria lactucae Pers. - Delaware.

Mosaic, which has recently been described by Jagger (Jagger, I. C. A transmissible mosaic disease of lettuce. Jour. Agr. Res. 20: 737-739. 1921), was reported by Newhall and Dye as being unusually prevalent in New York, where it caused from 8 to 10% loss in the largest lettuce growing sections.

Jagger (News Notes, Office of Cotton, Truck, and Forage Crop Disease Investigations, May 7) reported mosaic as less destructive than it was two years ago in the Beaufort, South Carolina lettuce district. Occasional plants were found affected, and in a few cases 25% or more showed mosaic, but in general the loss was slight. Jagger (l. c., Mar. 2) also reported mosaic as an important factor in the failure of lettuce crops at Sanford, Florida, during January and February.

Tipburn (non-parasitic) - New York (very important, reducing the yield 15 to 18% and affecting the first crop from the middle of June to the middle of July), Texas (prevalent; 2% loss), Idaho (considerable loss in the Lewiston district, probably due to the hot dry weather conditions).

Bacterial soft rot (species undetermined) - Many collaborators report soft rots of lettuce in both field and greenhouse, causing decay of heads. In some cases this is a bacterial rot following tipburn or lesions produced by other causes. This condition was reported in 1921 from South Carolina (under the name of "black heart" - Jagger, l. c., May 7. See mosaic), Michigan (100% loss in some fields), Minnesota (injury to small plants following tipburn), Colorado (important locally), Arizona (Casa Grande district and Rillito Valley; on Boston Market following February frosts, some fields reported as entirely ruined).

Black heart (cause unknown), which produced an internal decay of the heads, was reported from the Imperial Valley, California as being more severe than previously, causing 6% loss.

"White heart" was very severe this year in New York. In past seasons this disease was not at all serious, and only an occasional heart affected with this trouble would be seen as one passed through a field. This year 8% occurred throughout the season, and during the latter part from 25 to 65% of the heads in all fields were made unmarketable. (H. W. Dye, Jan. 28, 1922).

Decay due to Alternaria sp. - King County, Washington.

Rhizoctonia rot - This disease, first described in literature under the name of black root, and also called bottom rot, black bottom, rosette, and stem rot, is reported in 1921 from New York as attacking the late crop and reducing the yield from 8 to 12%; from Pennsylvania as causing 20% loss in one field, being worse on Big Boston than on other varieties; and in the rosette form from Ohio and Indiana.

Dye, H. W. The bottom-rot disease of western New York lettuce. (Abstract) Phytopath. 12: 48. Jan. 1922.

Damping-off, caused by Pythium debaryanum Hesse - occurred in Connecticut. Clinton also reports the isolation of another Pythium with a spiny oogonium, which may itself be injurious, or merely following P. debaryanum.

Pythium root rot (species not determined) - Michigan (on both field and greenhouse lettuce; 5 to 10% loss caused in some greenhouses).

Root rot caused by Fusarium sp. was reported as the limiting factor in the production of high grade lettuce in Kentucky. It caused a reduction in yield for the state of 60%. The plants fail to head properly after they have made a good start. High temperatures favor rapid development of rot, and the disease caused greatest injury in late spring, both in the field and in greenhouses.

Root knot caused by Heterodera radicicola (Greef) Mill. - unimportant in South Carolina and Ohio.

Dodder (Cuscuta sp.) - Missouri.

MANGEL-WURZEL

Rhizoctonia sp. - Washington.

OKRA

Root knot caused by Heterodera radicicola (Greef) Müll. - Texas, 2% reduction in yield.

Root rot caused by Ozonium omnivorum Shear was very prevalent in Texas, causing a 20% reduction in yield.

Wilt caused by Fusarium vasinfectum Atk. - 1% loss in Texas.

Macrosporium hybiscinum Thüm. - Clark County, Ohio, September 23.

PARSNIP

Leaf spot caused by Cercosporella pastinacae Karst. - Indiana (considerable importance in market gardens, causing a mottling of the leaves; first seen September 7 in Marion County).

Common scab caused by Actinomyces scabies (Thaxter) Güss. A specimen was sent in to the laboratory at Cornell from Madison County, New York, March 24.

PEA

Root rots caused by various organisms

"A survey of Montana, Idaho, and Utah indicates that there are incipient cases of pea root-rot in nearly all the important districts and that under present conditions it will be only a matter of time before this type of trouble is as widespread as it is in the East..... The western climate cannot be depended upon to keep plants healthy. Growers should therefore watch carefully for the appearance of pea root-rots and practice the longest possible rotation to prevent its development. The situation is not one to justify undue alarm, but these findings should be taken seriously if the interests of the pea crop in later years are to be safeguarded." (U. S. Dept. Agr. Weekly News Letter, Nov. 9, 1921).

It was estimated by F. R. Jones that the pea crop in Morgan Valley, Utah was reduced 10% by root rot, individual fields showing losses of 25 to 30%. Milbrath reports the losses from this cause heavy in San Diego, Orange, and Los Angeles Counties, California, where high temperatures prevailed. The reduction in yield for the state was estimated at 15%. F. R. Jones also reports root rot as unusually destructive in the Baltimore trucking district of Maryland, due to unfavorable weather.

Root rot associated with Fusarium sp. - New York (serious in Suffolk County), New Jersey (serious in southern part of state), Delaware (very important), Maryland (severe on infested soils, becoming more prevalent), Wisconsin, and Montana (found in Gallatin, Paradise, and Montana Valleys in July).

Root rot associated with a Pythium first appeared at Highwood, Connecticut, May 26. In Delaware it caused severe loss in fields which have been cropped for a number of years to peas. It was the limiting factor in some fields in Wisconsin, but the loss was difficult to estimate because of very

hot, dry weather. It was found in the Gallatin and Paradise Valleys, Montana, in July, occurring generally in pea-growing sections, especially in fields where peas have been grown for many years.

Rhizoctonia root rot was reported from Wisconsin as prevalent in the older pea-growing sections. Early and canning peas were affected in the vicinity of Greeley, Colorado.

Other diseases

Bacterial blight caused by Pseudomonas pisi Sackett - Delaware (very important), Maryland (damaged by blight on Eastern Shore where exposed to early freezes), Indiana (noted May 20 in one field in Marion County), North Dakota (slight), Montana (unimportant), and Colorado (not serious).

Blight caused by Ascochyta pisi Lib. - severe in Delaware, Maryland, and California; unimportant in New York, New Jersey, and Wisconsin; not seen in Virginia, Ohio, Montana, and Colorado.

Downy mildew caused by Peronospora viciae Berk. - of minor importance in Delaware, Tennessee, and Wisconsin.

Powdery mildew caused by Erysiphe communis Fr. - New York (important in one field in Allegany County), Colorado (present at Fort Collins in July), Idaho (common in late garden peas), Washington, and California (very severe in Riverside and San Diego Counties, destroying whole fields in Riverside County, and causing a 2% reduction in yield for the state).

Septoria blight caused by Septoria pisi West. was reported as being unimportant in New Jersey, Wisconsin, Montana, and Colorado. Adams reports it as much more prevalent than last year in Delaware, especially on plants weakened by the late frosts in the spring. First observed May 21 at Georgetown.

Anthracnose caused by Colletotrichum pisi Pat. (See Vaughan, R. E. and Fred R. Jones. Colletotrichum pisi Pat. on garden peas. (Abstract) Phytopath. 12: 1922., also Hemmi, Takewo. Endô no tansobyô (Anthracnose of pea). Jour. Plant Prot. 8: 229-233. May 1921).

Spot caused by Mycosphaerella pinodes Berk. and Blox. - Wisconsin.

Mosaic. "Green peas were also affected by mosaic and mottling was observed on the flowers of purple varieties." (Dickson, B. T. Maladies des plantes en 1920-21. Ann. Rep. Quebec Soc. Prot. Plants 13 (1920-21): 66-67. 1921).

Dodder (Cuscuta sp.) - one report from Missouri.

Blasting due to hot weather caused almost 100% loss in Michigan.

PEANUT

Leaf spot caused by Cercospora personata B. & C. was reported from West Virginia, North Carolina, South Carolina, Florida, Alabama, and Arkansas as comparatively unimportant, although some collaborators report the disease as general and causing rather serious defoliation. The following publication is worthy of record: Bal, S. N. Commentationes mycologiae 8-10. Jour. Dept. Sci. Uni. Calcutta 3 (Bot.) 8 p. pl. 1921.

Wilt or blight caused by Bacterium solanacearum EFS - more prevalent than usual in North Carolina.

Rust caused by Puccinia arachidis Lag. had already been found in Florida before the publication by J. C. Arthur of a note concerning its probable

seriousness if introduced into the United States (Two destructive rusts ready to invade the United States. Science n. s. 51: 246-247. March 5, 1920). It was discovered by C. D. Sherbakoff in a field on the farm of the experiment station at Gainesville, August 30, 1918, and was apparently of no importance. O. F. Burger reported the collection of the disease in November 1920 at Torrey Island, Florida, where it was said to be causing 50% loss in a 15 acre field, but not to occur in other fields. (See Pl. Dis. Bul. 5: 51-52, 88. 1921).

Tipburn, of which leaf-hoppers were the suspected cause, was reported from South Carolina.

Ozonium root rot, caused by Ozonium omnivorum Shear - was prevalent on black lands in Texas, causing 10% loss.

Sclerotial blight caused by Sclerotium rolfsii Sacc. was prevalent on light sandy soils in Texas (loss 1%); slight in Alabama; important in North Carolina (1% loss).

Chlorosis due to excess of lime in the soil caused .5% loss in Texas.

PEPPER

Mosaic, cause unknown, - vicinity of Chattanooga, Tennessee (affecting about 10% of the plants of Giant King and a few plants in a field of Ruby King - Sherbakoff. See also potato), New Jersey (common, in some cases causing heavy loss), Pennsylvania, Indiana (considerable damage), and California (.5% loss, affecting the winter crop in Orange and San Diego Counties - Milbrath).

Anthracnose caused by Colletotrichum nigrum E. & H. - 1% loss in West Virginia.

Leaf blight caused by Cercospora sp. - Palmetto, Florida. (Jagger).

Bacterial spot (Bacterium vesicatorium Doidge). Sherbakoff reports the "bacterial warty leaf spot" reported from Texas by Heald and Wolf and by himself from Florida as causing slight damage in Tennessee in 1921. Gardner reports the production of typical lesions on pepper with pure cultures from tomato. For discussion of probable relationships see Gardner, Max W. and James B. Kendrick. Bacterial spot of tomato. Jour. Agr. Res. 21: 123-156. April 15, 1921. (Cf. also Takimoto, Seitô. Tôgarashi no saikinbyô (A bacterial disease of red pepper). Byochu-gai Zasshi (Jour. Plant Prot. 8: 510-511. 1921).

Sclerotium blight, (Sclerotium rolfsii Sacc.) was locally severe in South Carolina.

Root rot and wilt, caused by Fusarium sp. The former trouble was reported as doing 1% damage at Chattanooga, Tennessee (Sherbakoff); and wilt on pimentos was reported from Orange County, California, doing 5% damage. (Milbrath).

Macrosporium fruit rot - Arizona (50% damage in one field).

Damping-off due to Rhizoctonia sp., Botrytis sp., and Sclerotinia libertiana Fckl. was serious in Connecticut.

Rhizoctonia rot - New Jersey (serious in a few cases), Pennsylvania.

Bacterial wilt, caused by Bacterium solanacearum EFS - Pennsylvania (on long red cayenne pepper at Freeland - Weiss), Texas (Kinney County).

Nematode injury, Heterodera radicicola (Greef) Müll., was common on eggplant and peppers, Freeland, Pennsylvania. (Weiss).

Leaf fall, cause unknown, was serious in some cases in New Jersey.

Sunscald did considerable damage in Indiana.

RHUBARB

Crown and stalk rot, caused by *Phytophthora* sp., was reported from Pennsylvania as first appearing August 13 in Philadelphia County, causing 20% damage in one field. A rot similar as far as aspect is concerned is described by Sherbakoff, but is tentatively attributed by him to *Phytophthora terrestris*. He makes the following statement concerning the disease in Tennessee:

> "Phytophthora rot, closely associated in place and etiology, in the field with buckeye rot of tomatoes, had been observed in a few fields, in one case killing about 75% of the plants. The evidence at hand indicates that the disease is very common in the state, especially in the western part. I believe that the disease is the chief factor of failure of rhubarb culture in the entire southeast, undoubtedly so in Florida and Tennessee." (See also Pl. Dis. Bul. 5: 102. Sept. 15, 1921).

Anthracnose caused by *Colletotrichum erumpens* Sacc. - very severe in Barbour County, West Virginia in September.

Leaf spot caused by *Phyllosticta* sp. - Center County, Pennsylvania.

Leaf spot caused by *Ascochyta rhei* Ell. & Ev. - of considerable importance at Indianapolis, first appearing May 20 on leaf and petiole.

SALSIFY

White rust caused by *Albugo tragopogonis* Pers. - New York (very common), Kansas (at Sedgwick).

Rust caused by *Puccinia tragopogi* (Pers.) Cda. - Idaho.

Powdery mildew was found in Doniphan County, Kansas, August 8.

SPINACH

Downy mildew caused by *Peronospora effusa* Rabenh. was reported as serious in Indiana greenhouses in March; as very prevalent in Texas, causing 15% reduction in yield; as very severe in Imperial, Los Angeles, and Sacramento Counties, California, causing 100% infection in the Imperial Valley and a 15% reduction in yield for the state. Milbrath reports as follows on May 4:

> "During the season of 1920-21 there were about 800 acres of spinach in the Imperial Valley. On December 30, about 50% of the acreage had been plowed under on account of mildew. I found the disease in all fields to an extent of 50% severe infection. Owing to the disease and poor market, shipments were few, and a small outlet was found through a cannery in San Diego. Today's report shows a total of 36 cars shipped from the whole state during the season, in contrast with 275 cars last season. Of the 36 cars I know of, 12 were shipped from the Valley, where 300 were expected."

Anthracnose caused by *Colletotrichum spinaciae* E. & H. - unimportant in Texas.

Rust caused by Uromyces fabae (Pers.) DeBy. - was reported by Fields as present in Alameda County, California, and probably in San Mateo County also.

Leaf rust caused by Puccinia subnitens Diet. - Clemenceau, Arizona.

Mosaic (cause unknown) - unimportant in Indiana, locally important in Illinois, first report of the disease; 100% in one field in Minnesota; severe in California, controlling factor in the El Monte district. (See also Smith, Loren B. Notes on spinach breeding. Amer. Hort. Soc. Proc. 17: 146-155, and Smith, L. B. Breeding mosaic resistant spinach and notes on malnutrition. Virginia Truck Exp. Sta. Bul. 31/32: 137-160. Ap./Je. 1920 (1921)).

Crown rot caused by Phytophthora sp. - Indiana (destroyed 50% of the plants in one patch at Lafayette, under Skinner irrigation; first noted June 21; high temperatures probably favored the fungus).

Wilt caused by Fusarium sp. - Idaho (of no great importance, found in the Lewiston district).

Damping-off caused by Pythium debaryanum Hesse was causing slight injury to young seedlings in the field at Highwood, Connecticut, April 11.

Root knot caused by Heterodera radicicola (Greef) Müll. - Elkhart County, Indiana, September 9.

Malnutrition (See Smith, L. B. l. c. under mosaic).

Annualism (running to seed) - western Washington (very prevalent; probably due to nutritional and climatic conditions - Frank).

SWISS CHARD

Leaf spot caused by Cercospora beticola Sacc. - unimportant in West Virginia, Texas, and Colorado.

Rust caused by Uromyces betae (Pers.) Lev. - South San Francisco and Colma districts, California (W. S. Fields).

THE PLANT DISEASE BULLETIN

Issued By

THE PLANT DISEASE SURVEY

Supplement 23

Diseases of Forest and Shade Trees, Ornamental and Miscellaneous Plants in the United States in 1921

August 15, 1922

BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

PLANT DISEASE SURVEY

1922

G. R. Lyman, Pathologist in Charge

R. J. Haskell, Assistant Pathologist — G. H. Martin, Jr., Pathologist

List of collaborators of the Plant Disease Survey who have made the principal contribution to the 1922 annual summary.

It should be understood that many other collaborators and pathologists have assisted in gathering data within the States but the following list includes those who actually furnished state reports to the Washington office.

Alabama	W. A. Gardner
Arizona	J. G. Brown
Arkansas	J. A. Elliott
California	J. T. Barrett
	W. T. Horne
	D. G. Milbrath
Colorado	C. D. Learn
	Ellsworth Bethel
Connecticut	G. P. Clinton
Delaware	J. F. Adams
Florida	O. F. Burger
	H. E. Stevens
Georgia	T. H. McHatton
Idaho	C. W. Hungerford
	Henry Schmitz
Illinois	H. W. Anderson
	F. L. Stevens
	L. R. Tehon
Indiana	M. W. Gardner
Iowa	I. E. Melhus
Kansas	L. E. Melchers
Kentucky	W. D. Valleau
Louisiana	C. W. Edgerton
Maine	W. J. Morse
Maryland	C. E. Temple
	R. A. Jehle
Massachusetts	A. V. Osmun
	P. J. Anderson
Michigan	G. H. Coons
Minnesota	E. C. Stakman
	J. G. Leach
Mississippi	D. C. Neal
Missouri	E. F. Hopkins
Montana	H. M. Jennison
	D. B. Swingle
	A. L. Straus
Nebraska	R. W. Goss
Nevada	C. W. Lantz
New Hampshire	O. Butler
New Jersey	M. T. Cook
New York	Charles Chupp
	L. C. Petry
North Carolina	L. E. Yocum
	A. C. Foster
North Dakota	H. L. Bolley
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Ohio	A. D. Selby
	R. C. Thomas
	Freda Detmers
Oklahoma	Robert Stratton
Oregon	H. P. Barss
	J. S. Boyce
	S. M. Zeller
Pennsylvania	C. R. Orton
	H. W. Thurston
	L. O. Overholts
Rhode Island	H. W. Browning
	W. A. Snell
South Carolina	C. A. Ludwig
South Dakota	E. J. Petry
Tennessee	L. R. Hesler
Texas	J. J. Taubenhaus
Utah	B. L. Richards
Vermont	B. F. Lutman
Virginia	F. D. Fromme
Washington	F. D. Heald
	B. F. Dana
	Arthur Frank
West Virginia	N. J. Giddings
	J. L. Sheldon
	E. C. Sherwood
	Anthony Berg
Wisconsin	R. E. Vaughan
Wyoming	Aven Nelson

DISEASES OF FOREST AND SHADE TREES, ORNAMENTAL AND MISCELLANEOUS PLANTS IN THE UNITED STATES IN 1921

Prepared by
G. Hamilton Martin, Jr.

CONTENTS

Foreword

The summary of the diseases of forest and shade trees, ornamental and miscellaneous plants has been prepared by utilizing the following sources of information: (1) collaborators (2) specialists in the offices of Forest Pathology and Blister Rust Control (3) articles in botanical journals and (4) special reporters. In the case of the last two groups initials have been used in place of the full name of the reporter. A list of collaborators is given on the opposite page. The names of the special reporters are as follows:

JA = Jacob Albrecht
EB = Ellsworth Bethel
FWB = F. W. Besley
JSB = J. S. Boyce
STD = S. T. Dana
D = J. J. Davis (Provisional list of parasitic fungi and their hosts of Wisconsin)
WSF = W. S. Fields
BF = Bruce Fink (Notes on powdery mildews of Ohio. Ohio Jour. Sci. 21: 211-216. April 1921)
GHG = G. H. Godfrey
GFG = G. F. Gravatt
RJH = R. J. Haskell
LOK = L. O. Kunkel (A possible caucative agent for the mosaic disease of corn. Bul. Exp. Sta. Hawaiian Sugar Plant. Assoc. 3 (1) July 9)
PAL = P. A. Lehenbauer
AM = Alexander MacElwee
EBM = E. B. Mains (Cereal Courier 13: 9. April 30, 1921)
EBM (2) = E. B. Mains (Unusual rusts on Nyssa and Urticastrum. Am. Jour. Bot. 7: 442-451. Nov. 1921.
GHM = G. H. Martin
JM = J. Matz
BMc = Bright McConnell
IEM = I. E. Melhus (Mosaic studies. Phytopath. 12: 42. Jan. 1922
WM = Woodbridge Metcalf
DGM = D. G. Milbrath
LOO = L. O. Overholtz
CVP = C. V. Piper
CMS = C. M. Scherer
S&D = Shear, C. L. and Dodge, B. O. (Mycologia 13: 135-170. May 1921)
JLS = John L. Sheldon
JAS = John A. Stevenson
HET = H. E. Turley
CAW = C. A. Weigel
FW = Freeman Weiss
SMZ = S. M. Zeller

A general summation of the distribution and prevalence in the United States of the diseases of the hosts mentioned in this summary has been made impossible due to the lack of the necessary data. Therefore it is necessary to issue the information in list form with here and there a few scattered general notes. Data have been taken from reports of past years in the case of the Coniferae and certain of the ornamental hosts.

No doubt a great many of the diseases listed in the following pages are nation-wide in their distribution, but owing to lack of attention by pathologists in general to the diseases of these plant groups, definite data are not available for summarizing.

This past season an effort has been made to gather more detailed information on certain important conifers. A few reporters responded most helpfully. Later it is hoped to do the same with certain important hardwoods used either for economic or ornamental purposes.

With the growing realization of the value of our trees and ornamental plants may there also be impressed upon the mind the necessity of protecting these groups of hosts from disease havoc. During 1921 the climatological phenomena were unusual with regard to rainfall and temperature. The weather for 1921 and the temperature by months has been summarized in Plant Disease Bulletin Supplement 20. Since the growing realization of meteorological effects upon trees and ornamental plants is increasing, it is hoped that more attention will be paid to this phase of pathology.

Soil conditions play an important role also in shade tree and ornamental plant health, as it so often happens that transplantings are made to situations that are wholly unfavorable for growth.

An effort has been made to present a more complete list of references pertaining to the diseases of plants given in this summary.

The authority for the scientific names of the forest trees of the United States has been George B. Sudworth's "Check List of the Forest Trees of the United States." Scientific names of all other trees have been taken from Bailey's "Standard Cyclopedia of Horticulture."

The following report on meteorological effects in the Pacific Northwest has been prepared by J. S. Boyce, Office of Forest Pathology:

Winter Injury: The winter of 1919-1920 in the region west of the summit of the Cascade Mountains was characterized by a long period of drouth and unprecedented low temperatures. The results were apparent in the spring and summer of 1920 when the injury became apparent on trees and shrubs. Large ornamental chestnut trees (*Castanea dentata*) were killed outright, especially in the neighborhood of Oregon City. Even the native species did not escape. Dogwood (*Cornus nuttallii*) was frequently top killed.

Snow and Ice Damage: During the latter part of November and early December 1921 a snow and ice storm of unusual severity swept through the gorge of the Columbia River. Considerable damage was caused to the hardwoods by branches and tops breaking under the heavy load of snow and ice, and to second growth conifers by breaking of the tops. Douglas fir suffered considerably. However, the area of damage is not extensive.

Wind Damage: On January 29, 1921 a wind storm swept the west coast of Washington and extended inward for about 100 miles. At Grays Harbor the wind reached a recorded velocity of over 140 miles per hour before the instrument was wrecked. It has been estimated that more than six billion feet board measure of merchantable timber was blown down by this storm, most of which cannot be salvaged and becomes a total loss.

A cruise of a portion of the area this past summer by the U. S. Forest

Service shows a total loss of 14.4% and the relative damage by species.

Species	Per cent
Douglas fir (Pseudotsuga taxifolia)........................	6.1
Western hemlock (Tsuga heterophylla)......................	18.9
Silver fir (Abies amabilis)................................	16.7
Western red cedar (Thuja plicata).........................	6.2
Sitka spruce (Picea sitchensis)...........................	9.8

Naturally the shallow rooted hemlock and silver fir, and to a lesser degree spruce, suffered most severely. Sound trees were uprooted by the force of the wind. The excessive winter rainfall previous to the storm favored this by softening the soil. Trees with butt rot caused by the velvet top fungus (Polyporus schweinitzii) were usually broken off from the ground level to a height of 15 feet.

Dr. J. H. Faull has ably presented some forest problems he finds existent in Ontario which can well be applied to our forests also. Therefore, herewith is copied some of his remarks from "Some problems of forest pathology in Ontario." Jour. Forestry 20: 67-70. Jan. 1922.

> "Buttrots constitute the outstanding destructive agencies at work in our Ontario forests. No forest is exempt, and every mature stand becomes more and more susceptible with increasing age. The time inevitably comes when they bring about an accelerated loss of stumpage values through deterioration. They are also responsible for most windfalls and consequently for the vast amounts of debris that litter the floors of our forests, affording a limitless supply of highly combustible wasted materials. And finally butt rots are dominant influences in relation to the succession of cover types in unregulated forests. Fortunately they are almost altogether restricted to mature or suppressed timber; young trees are practically immune. This fact greatly simplifies the problem of control. Plainly butt rot problems will be very largely solved in the administration of any good policy of forest management.
>
> "One of the unexpected drawbacks encountered in investigating butt rots has been the lack of information on even the identity of the causal organisms. This applies especially to the larger number of butt rots of conifers. Balsam rots may be cited as an extreme case; though several types occur in living balsam trees, nobody as yet, so far as the literature shows, has definitely established a connection with a specific causal factor in any single case. To help meet this situation investigations were begun two years ago, and are now being carried on with fruitful results. The methods employed are those so successfully used in cultural diagnostic studies of bacteria.
>
> "But there are other fundamental problems of even greater importance calling for solution, such for example as the rate of progress of butt rot infestations, the relation of butt diseases to the age of the host species, to the specific resistance of the host and to environmental factors. And here we would include such topics as soil characters, crowding, mixed stands, and climate, all of which have a direct bearing on the relation of butt diseases to yield and hence to the question of the right time of harvesting. The solution of these problems will demand time,

patience, and a force of trained investigators, but the results attained will be of the greatest value in the administration of our forests of today and tomorrow."

DISEASES OF CONIFERS

ARBORVITAE (Thuja occidentalis)

Diplodia sp.
Alabama (JFC)

Keithia thujina Durand
Virginia, Wisconsin

Leptosphaeria sp.
Pennsylvania

Macrosporium sp.
Indiana (JFC)

Mycosphaerella sp.
Pennsylvania, Alabama

Pestalozzia conigena Lev.
Minnesota

Pestalozzia funerea Desm.
Virginia, North Carolina, Mississippi

Pestalozzia sp.
Alabama (JFC)

Phoma thujana Thüm.
New Jersey (JFC), Michigan (JFC)

Recurvaria thujaella Kearf.
New York (JFC)

Septobasidium sp.
North Carolina (JFC)

Root rot caused by unfavorable cultural conditions
New York

Leafscorch
New York, Nebraska

Winter injury
Maine, Ohio, Minnesota, Iowa (JFC)

Dieback caused by lack of soil moisture
Pennsylvania

Tip-dying, cause undetermined
New Jersey

ARBORVITAE, CHINESE (Thuja orientalis)

Nursery blight caused by *Phoma* sp.
Pennsylvania, Illinois, Iowa, Nebraska, and Kansas

Chlorosite, cause undetermined
Kansas

Winter injury
Kansas

CEDAR, INCENSE (Libocedrus decurrens)

Heartwood rot caused by *Polyporus amarus* Hedgc.
Oregon - Jackson (JSB)
Widespread throughout range of host and causing losses up to 50% or more in overmature stands. (JSB)

Incense cedar rust caused by Gymnosporangium blasdaleanum (D.& H.) Kern
Oregon
This disease is characterized by the formation of conspicuous, compact witches' brooms. Individual sprays may be killed outright. Swellings on the limbs or the bole sometimes result from infection. The disease is widespread throughout the range of the incense cedar and where severe greatly retards the growth of the host. (JSB)

Stigmatea sequoiae (Cke. & Hk.) Sacc. is found on living leaves of incense cedar in California and southern Oregon rather frequently. Weakly, if at all parasitic and causing no apparent injury to the host. (JSB)

CEDAR, RED (Thuja plicata)

Stringy butt rot caused by Poria weirii Murr.
Washington - occasional; causes small amount of cull, decay only in heartwood and confined to stump butt log. (JSB)

Buttrot of heartwood, cause undetermined
Washington (JSB)
The decay closely resembles that caused in other species by Polyporus schweinitzii. Common in Washington and probably also in Oregon; causes a small amount of cull. (JSB)

Leaf blight caused by Hendersonia thyoides Cke. & Ell.
Oregon (JSB) - Rare, of no economic importance.

Cedar leaf-blight caused by Keithia thujina Durand
Washington, Oregon - (JSB)
Common throughout range of the host, principally attacks small trees and when severely attacked the trees from a distance look as though they had been scorched by fire, the disease also retards the growth of infected trees, but exact figures on loss increment are not yet available. (JSB)

FIR, SILVER (Abies amabilis)

Needle cast caused by Lophodermium nervisequium Hart.
Oregon - causes premature shedding of older needles. (JSB)

Fir-fireweed rust caused by Pucciniastrum pustulatum (Pers.) Diet.
Washington - occasional, on needles of the season. (JSB)

Fir-blueberry rust caused by Calyptospora columnaris (Alb. & Schw.) Kühn
Washington (JSB)

Mistletoe caused by Razoumofskya occidentalis abietina (Engelm.) Coville
Oregon

FIR, BALSAM (Abies balsamea)

Fir-blueberry rust caused by Calyptospora columnaris (Alb. & Schw.) Kühn
Pennsylvania - very local in central part of state, infected leaves die and fall off. (LOO)

Fir-chickweed rust caused by Melampsorella elatina (Alb. & Schw.) Arth. = M. cerastii (H. Mart.) Schroet.
Wisconsin

Fir-fern rust caused by Uredinopsis mirabilis (Pk.) Magn.
Wisconsin

Fir Phoma (Phoma sp.)
New York

Twig blight, cause unknown
Michigan

Witches broom, cause unknown
Michigan

FIR, WHITE (Abies concolor)
Stringy brown rot caused by Echinodontium tinctorium Ell. & Ev.
Idaho - general and common throughout state, severe.
Oregon - Baker (Whitney, Oct. 28, 1920), Grant (Bates, Oct. 14, 1920) Klamath (Bly, Nov. 13; Odessa, Sept. 14; Recreation, Sept. 13) and Wasco (Dufur, Oct. 8; Friend, Sept. 21) Counties. Stringy brown rot of the heartwood caused by the Indian paint fungus results in enormous loss in merchantable timber. The decay is widespread throughout the range of the host, but the stands in the Klamath Lake region and in eastern Oregon are severely affected. A cruising rule in the Blue Mountains of the eastern part of the state is to consider all trees over 18 inches in diameter at breast height as worthless and cull all smaller trees 25%. An investigation was conducted on the Crater National Forest on the stringy brown rot during which it was found that 44% of all the infections entered through fire scars. (JSB)

Needle cast caused by Lophodermium nervisequium Hart.
Oregon - Baker (Whitney, Oct. 28, 1920), Grant (Bates, Oct. 14 1920) Klamath. Very common attacking the older needles and varying greatly in severity, not only in different localities, but on individuals in the same locality, mostly on saplings and small poles. This disease causes a premature death and shedding of the older needles. The increment of infected trees is reduced more or less, depending on severity and continuity of attack. (JSB)

Fir needle cast caused by Phacidium infestans Karst.
Oregon - rare, not important. (JSB)

Fir-blueberry rust caused by Calyptospora columnaris. (Alb. & Schw.) Kühn
The two observations reported are Peridermium ornamentale Arth. considered by some to be the aecia of C. columnaris. (JSB)
Oregon - on needles of the season. (JSB)

Witches broom caused by Razoumofskya occidentalis abietina Englm. Coville
Oregon - reduces increment of infected trees. (JSB)

FIR, LOWLAND WHITE (Abies grandis)
Stringy brown rot caused by Echinodontium tinctorium Ell. & Ev.
Washington, Oregon - (JSB)

Probably occurs throughout the range of the host, causes considerable loss in mature timber. (JSB)

Rot caused by Fomes officinalis Fr.
Oregon - not uncommon in the Coast Range of the western part of state.

Red-brown sapwood rot caused by Fomes pinicola (Fr.) Cke.
Washington (JSB)
Oregon - very common on fallen logs in western Oregon.
Found occasionally on living trees; of little economic importance. (JSB)

White root rot caused by Polyporus dryadeus Fr.
Washington - found on a living tree, rare, not economically important. (JSB)
Oregon - one specimen collected; the tree was apparently living.

Fir-willow rust caused by Melampsora arctica Rostr.
Oregon - rare, of no importance. (JSB)

Witches broom caused by Razoumofskya occidentalis abietina (Engelm.) Coville
Washington (JSB)

Yellow witches broom caused by Melampsorella elatina (Alb. & Schw.) Arth.
Oregon - rare; of no importance; a caeoma which seems to belong here has been found on needles of the season. (JSB)

Matting caused by Herpotrichia nigra Hart.
Idaho.
This disease has been reported as doing great damage in Europe by killing and matting the leaves of Abies.

Yellow root rot caused by Sparassis radicata Weir
Oregon - observed once.

Sooty mold caused by Dimerosporium sp.
Washington (JSB)
Occasional throughout range of host, of no economic importance, apparently little or not at all injurious to the host, on older needles. (JSB)

Cladosporium sp.
Idaho - 1915; perhaps saprophytic only. (JFC)

Needle cast caused by Lophodermium nervisequium Hart.
Oregon (JSB)
Common throughout the range of the host, causes premature shedding of older needles. (JSB)

Fir-Fireweed rust caused by Pucciniastrum pustulatum. (Pers.) Diet.
Idaho
Washington - widespread in western part of state, of little economic importance, kills needles of the season. (JSB)

Fir-Athyrium rust caused by Uredinopsis copelandi Syd.
Washington - rare. (JSB)

Fir-fern rust caused by Uredinopsis mirabilis (Pk.) Magn.
Washington. (JSB)
Oregon. (JSB)
Common throughout the range of the host, on needles of the previous season which are killed, injury to host is slight. (JSB)

FIR, ALPINE (Abies lasiocarpa
Matting caused by Herpotrichia sp.
Idaho

Yellow witches broom caused by Melampsorella elatina (Alb. & Schw.) Arth.
Utah

FIR, RED (Abies magnifica)
Witches broom caused by Razoumofskya occidentalis abietina (Engelm.) Coville
Oregon
California - in the Mt. Shasta region of northern California this mistletoe causes the witches broom of red fir; infected branches are commonly killed by the parasite; impossible to estimate aggregate damage, but on the whole not serious. (JSB)

FIR, NOBLE (Abies nobilis)
Witches broom caused by Razoumofskya occidentalis abietina (Engelm.) Coville
Oregon

FIR, SHASTA (Abies shastensis)
Stringy brown heartwood rot caused by Echinodontium tinctorium Ell. & Ev.
Oregon
California - most prevalent in Mt. Shasta region of the northern part of state. (JSB)
Occasional throughout range of the host, small amount of loss caused. (JSB)

FIR (Abies spp.)
Witches broom, cause unknown.
Washington

Cladosporium sp.
Rhode Island (JFC)

Cytospora pinastri Fr.
Wisconsin (JFC)

Fusicoccum abietinum (Hart.) Prill & Del. = (Phoma abietina Hart.)
New Hampshire (JFC)

Macrosporium sp. or Alternaria sp.
Indiana (JFC)

Pestalozzia sp.
District of Columbia (JFC)

Brown root and butt rot caused by Fomes annosus Fr.
Oregon - infrequent in western part of state on fallen logs and upturned roots of fallen trees.

Rot caused by Trametes carnea Wettst.
Oregon - the most common wood-destroying forms on fallen Abies spp. in western Oregon.

Rot caused by Polyporus fissus Berk.
One of the common wood destroying forms found on down logs in western Washington and Oregon. (SMZ)

Red-brown root and butt rot caused by Polyporus schweinitzii Fr.
Common in western Washington and Oregon, but no special survey has been made. (SMZ)

DOUGLAS FIR (Pseudotsuga taxifolia)
The loss through decay in stands of Douglas fir in the Pacific Northwest is very large according to Dr. J. S. Boyce, Forest Pathologist, Office of Forest Pathology. He states that in certain cases the cull figure may reach 50% or more and that a loss of 20% in overmature stands is the rule rather than the exception. It is only in young stands of second growth that Douglas fir is relatively sound.

Dr. Boyce also states: "Four species of wood destroying fungi are responsible for all but an infinitesimal portion of the decay found in Douglas fir and these fungi are very widespread. They are the ring scale fungus (Trametes pini (Thore) Fr.) causing decay known as conk rot which extends throughout the tree, the velvet top fungus (Polyporus schweinitzii Fr.) causing red-brown butt rot usually confined to the stump and butt log, the quinine fungus (Fomes laricis (Jacq.) Murr.) causing brown trunk rot which extends throughout the tree, and the rose colored Fomes (Fomes roseus (Alb. & Schw.) Cke.) causing yellow-brown top rot commonly found in the upper portion of the bole or in the top. Of these, conk rot causes by far the greatest loss. Measurements of 170 mature, merchantable trees showed a total loss from decay of 45 per cent distributed as follows: conk rot, 39 per cent; red-brown butt rot, 2.5 per cent; brown trunk rot, 2 per cent and yellow-brown top rot, 1.5 per cent. In western Washington and Oregon fungi cause losses of from 20 to 50% or more of the merchantable timber in over mature stands."

Conk rot caused by Trametes pini (Brot.) Fr.
Washington (JSB)
Oregon (JSB)
The most common fungus destructive to merchantable timber in western Oregon.

Red-brown butt-rot caused by Polyporus schweinitzii Fr.
Washington (JSB)
Oregon (JSB)
Commonly found but not such a serious factor as Trametes pini. (SMZ)

Brown trunk rot caused by Fomes officinalis Fr.
Washington. (JSB)
Oregon (JSB)
Occasionally found.

Yellow-brown top rot caused by Fomes roseus (Alb. and Schw.) Cke.
Dr. S. M. Zeller says that the European form is seldom found but that a thin form which he is calling Trametes carnea is the most common fungus found on fallen logs in western Oregon.
Oregon (JSB)

Needle blight caused by Phacidium sp.
Oregon - occasional, retards growth of young trees. Ref. Jour. Agr. Res.: 10, No. 2, p. 99. (JSB)

Witches broom caused by Razoumofskya douglasii (Engelm.) Kuntze
Oregon (JSB)
Dr. Boyce reports that false mistletoe is serious but that fortunately it does not occur in the typical rain forests west of the Cascade Mountains and north of the Umpqua-Rogue River divide, and he continues, "but it is very frequent in southern and eastern Oregon and eastern Washington. Infected trees develop enormous brooms, in many cases the entire crown of large trees becomes a huge witches broom. Mature trees may be killed and the rate of growth of infected trees is much reduced."

Rust caused by Melampsora albertensis Arth.
Oregon - eastern part of state, occasional occurrence. (JSB)
California - northern section of state, occasional occurrence. (JSB)
Needles of the season are attacked but the resulting injury to the host is very slight, normally found on small saplings. (JSB)

Phomopsis disease caused by Phomopsis pseudotsugae Wilson
Reported as occurring in England and Scotland where the disease attacks stems and branches, causing swelling above affected area, cracking of bark or around edge of canker, girdling branch and causing death. In some cases the effect is very similar to Botrytis attack. Mention of this disease is made at this time in hopes that all interested in diseases of conifers will keep an open eye for any indication of this disease in the United States. Following are two references:

Alcock, N. L. A Phomopsis disease of Douglas fir. Gardiner's Chronicle III, 69: 45, Jan. 22, 1921, No. 1778.
Wilson, Malcolm. The diseases of the Douglas fir. Trans. Royal Scot. Arboricult. Soc., 35: 77-78. Sept. 1921.

Sap rot caused by Fomes pinicola (Fr.) Cke.
Washington.

Polyporus volvatus Pk.
Idaho - severe.
"Although this is not usually regarded as a tree disease in any of the general texts, states Dr. Henry Schmitz of the Forestry College, University of Idaho, "it is my opinion that it is one of the most

important. Field observations tend to indicate that the fungus comes in after trees have been injured by fire. The fungus seems to be parasitic, killing the bark, cambium and sapwood. I have observed fruiting bodies of this fungus in trees having a green healthy foliage and on trees which have evidently been killed by the fungus. This fungus would bear further investigation."

Sparassis radicata Weir
Montana, Idaho, Washington, and Oregon.

Needle blight caused by an undetermined fungus of the Stictidaceae
Montana and Idaho.

Meruliosa caused by Merulius americanus Burt and M. brassicaefolius Schw.
Oregon - rather common in western part of state.
These two fungi evidently do considerable damage in dimension timbers, both in the natural stands and in structures. (SMZ)

Damping off (cause unknown)
California - often rather serious in seed beds, acid treatment seems to give good protection. (WM)

Meteorological effects
California - cold winds or quick climatic changes in spring often cause death of new growth twigs and leaders. (WM)

Smoke poisoning
California - This host is quite sensitive to coal smoke in cities; in San Francisco and vicinity many trees have died from this. (WM)

HEMLOCK (Tsuga canadensis)
Twig blight caused by Cenangium balsameum var. abietis Pk.
Pennsylvania - On recently killed suppressed hemlocks, not known certainly to be a parasite. (LOO)

Leaf cone and twig rust caused by Melampsora abietis canadensis (Farl.) Ludwig
Pennsylvania - Almost entirely absent on trees where it was rather abundant in 1920. (LOO)
Wisconsin

Leaf rust caused by Pucciniastrum myrtilli (Schum.) Arth. = (Peridermium Peckii Thüm.)
Pennsylvania - central part of state; on an occasional leaf only as first observed June 23 when aecia were just bursting in two parallel rows on the lower surface. Vaccinium abundant in the locality where rust was found on needles. (LOO)

Ganoderma tsugae Murr. = (Fomes tsugae (Murr.) Sacc.)
Massachusetts (JFC)

Peridermium sp.
North Carolina, Wisconsin.

HEMLOCK, WESTERN (Tsuga heterophylla)

Stringy brown rot caused by Echinodontium tinctorium Ell. & Ev.
Washington (JSB)
Oregon - a resupinate form occasionally found
This rot of the heartwood appeared to be the most destructive decay of hemlock in the Pacific Northwest and is probably widespread throughout the range of the host. (JSB)

Heart rot caused by Trametes pini (Brot.) Fr.
Washington - not uncommon. (JSB)
Oregon - infrequently observed.

Sulphur heart rot caused by Polyporus sulphureus (Bull.) Fr.
Washington (JSB)

Root and butt rot caused by Fomes annosus (Fr.) Cke.
Washington - occasional, apparently causes little loss. (JSB)
S. M. Zeller notes its occurrence in the Pacific Coast Range as infrequent.

Red-brown sapwood rot caused by Fomes pinicola Fr.
Washington - occasional, resulting loss minor. (JSB)
This fungus commonly occurs on dead trees but is sometimes found causing decay of living trees. (JSB)
Not uncommon on standing hemlock and a real factor in decay of fallen logs. (SMZ)

Rust caused by Caeoma dubium Ludwig
Washington (JSB)

Sooty mold caused by Dimerosporium sp.
Washington - occasional throughout range of host, apparently causes no injury, or if it does it is very slight. (JSB)

Witches broom caused by Razoumofskya tsugensis Rosend.
Washington, Oregon. (JSB)
The false mistletoe causes pronounced witches brooms which reduces the increment of the host. Not severe in western Washington and Oregon. (JSB)

HEMLOCK, MOUNTAIN (Tsuga mertensiana)

Black felt-blight caused by Herpotrichia nigra Hart.
Oregon (JSB)

HEMLOCK (Tsuga spp.)

Pestalozzia sp.
New Jersey

Stysanus sp.
West Virginia (JFO)

Scorch caused by weather conditions
Connecticut

JUNIPER, SOUTHERN RED (Juniperus barbadensis)
Nursery blight caused by Phoma sp.
Reported found in Pennsylvania, Illinois, Iowa, Nebraska, and Kansas.

JUNIPER, DWARF (Juniperus communis)
Juniper needle cast caused by Lophodermium juniperinum (Fr.) de Not.
Washington, Oregon. (JSB)
In the instances of these findings the fungus was only weakly if at all parasitic. (JSB)

Rust caused by Gymnosporangium sp.
New Hampshire (JFC)

JUNIPER (Juniperus communis depressa)
Rust caused by Gymnosporangium clavipes Cke. & Pk.
Wisconsin

Rust caused by Gymnosporangium davisii Kern
Wisconsin

Rust caused by Gymnosporangium clavariaeforme (Jacq.) DC.
Wisconsin

JUNIPER (Juniperus communis sibirica)
Nursery blight caused by Phoma sp.
Pennsylvania, Illinois, Iowa, Nebraska, and Kansas.

JUNIPER, WESTERN (Juniperus occidentalis)
Heart rot caused by Fomes juniperinus Schrenk
Oregon (JSB)
Probably occurs throughout the range of the host. This fungus causes a great deal of decay which causes considerable loss when the trees are worked up for posts or pencil stocks. (JSB)

Sooty mold caused by Torula sp.
Oregon (JSB)
Probably occurs throughout the range of the host. Although this fungus was found growing on the resin from the glandular pits of the scale-like leaves it apparently was causing no injury. (JSB)

Leafless true mistletoe - Phoradendron ligatum Trelease
Oregon - occasionally found. (JSB)

Witches brooms caused by Gymnosporangium kernianum Bethel
Oregon (JSB)
Sometimes found. Causes a broom formation which is dense, compact and often globose in shape. (JSB)

JUNIPER (Juniperus pachyphloea)
Rust caused by Gymnosporangium gracilens (Pk.) Kern & Bethel
New Mexico
Nursery blight caused by Phoma sp.
Found in Pennsylvania, Illinois, Iowa, Nebraska, and Kansas
JUNIPER (Juniperus prostrata)
Nursery blight caused by Phoma sp.
Found in Pennsylvania, Illinois, Iowa, Nebraska, and Kansas.

JUNIPER, ROCKY MOUNTAIN (Juniperus scopulorum)
Rust caused by Gymnosporangium juvenescens Kern
Utah.

Rust caused by Gymnosporangium nelsoni Arth.
Utah

Nursery blight caused by Phoma sp.
Kansas

JUNIPER (Juniperus sibirica)
Rust caused by Gymnosporangium juniperinum (L.) Mart.
Utah

JUNIPER (Juniperus utahensis)
Rust caused by Gymnosporangium inconspicuum Kern
Utah

Rust caused by Gymnosporangium nelsoni Arth.
Utah

JUNIPER (Juniperus virginiana)
Dothidea sphaeroidea Cke.
Louisiana

Rust caused by Gymnosporangium germinale (Schw.) Kern = (Gymnosporangium clavipes Cke. & Pk.)
Found in New York, Pennsylvania, and Iowa.

Rust caused by Gymnosporangium globosum Farl.
Reported in Massachusetts, Pennsylvania, West Virginia, Wisconsin, Minnesota, Iowa, Kansas, and North Dakota.

Rust caused by Gymnosporangium juniperi-virginianae Schw. = (Gymnosporangium macropus Lk.)
Reported from Pennsylvania, New Jersey, Virginia, West Virginia, Georgia, Alabama, Wisconsin, Minnesota, Iowa, Nebraska, South Dakota, and Montana.

Rust caused by Gymnosporangium juvenescens Kern
Wisconsin

Rust caused by Gymnosporangium spp.
Massachusetts (JFC), New Jersey (JFC), Maryland, West Virginia, North Carolina, Iowa, North Dakota, South Dakota, and Montana (JFC).

Nursery blight caused by Phoma sp.
Pennsylvania, Illinois, Minnesota, Iowa, Nebraska, and Kansas.

Root rot caused by Polyporus purpureus Fr.
Iowa

Sphaeropsis juniperi Pk.
New York (JFC)

Macrosporium sp.
Kansas (JFC)

Fomes annosus Fr.
District of Columbia (JFC)

Cytospora sp.
Massachusetts (JFC)

Diplodia sp.
Pennsylvania

Chlorosis - non parasitic
Kansas

Winter injury
Kansas

Nursery blight - undetermined
Nebraska and Kansas

Heart rot - undetermined
Maryland

Root rot - undetermined
Alabama (JFC)

JUNIPER (Juniperus spp.)

Rusts caused by Gymnosporangium botryapites (Schw.) Kern
Massachusetts, Rhode Island, Connecticut, New Jersey, Pennsylvania and Alabama

Gymnosporangium clavariaeforme (Jacq.) DC.
Vermont and Michigan

Gymnosporangium germinale (Schw.) Kern = (Gymnosporangium clavipes Cke. & Pk.)
Connecticut (JLS)
Pennsylvania (CMS)
South Carolina - caused some damage to ornamental cedars near headquarters, Camp Jackson.
Reported in previous years from New York, New Jersey, Pennsylvania and Iowa.

LARCH (Larix laricina)
Larch willow rust caused by Melampsora bigelowii Thüm.
Wisconsin (JJD)

Larch-birch rust caused by Melampsoridium betulinum (Pers.) Kleb.
Wisconsin (JJD)

Heartwood rot caused by Trametes pini (Brot.) Fr.
Minnesota

LARCH, WESTERN (Larix occidentalis)
Brown trunk rot caused by Fomes officinalis Fr.
Oregon (JSB)
Probably distributed over range of host and causing considerable loss. (JSB)

Red brown heartwood butt rot caused by Polyporus schweinitzii Fr.
Oregon (JSB)
Probably distributed throughout range of the host. (JSB)

Heartwood rot caused by Trametes pini (Brot.) Fr.
Oregon (JSB)
Probably found throughout range of the host. (JSB)

Needle cast caused by Hypodermella laricis Tub.
Oregon (JSB)
Small trees are sometimes almost defoliated.

Larch mistletoe caused by Razoumofskya laricis Piper
Idaho - moderately important, very common on larch in certain sections of the Payette Lake region.
Oregon (JSB)
The mistletoe is widespread. It causes large witches' brooms which may ultimately result in the death of the tree. The rate of growth is greatly reduced and many trees are deformed by this disease. (JSB)

Needle blight caused by Lophodermium laricinum Duby
Idaho
Washington

Yellow root rot caused by Sparassis radicata Weir
Occurs in Montana, Idaho, Washington, and Oregon.

LARCH (Larix spp.)
Canker caused by Dasyschypha willkommii Hart.
Michigan

Parchment pore fungus rot caused by Polystictus pergamenus Fr.
Minnesota

Valsa abietis Fr.
Ohio

Phomopsis pseudotsuga

Wilson, Malcolm. A new recorded disease on Japanese larch. Trans. R. Scott. Arbor. Soc. 35: 73-74. September 1921.

Meria laricis Vuill.
Hiley, W. E. The larch needle-cast fungus. Quart. Journ. For. 15: 57-62. illus. pl. Jan. 1921. No. 1. Literature cited: p. 62.

Gymnosporangium globosum Farl.
Connecticut (JLS)
Minnesota
Reported previously from Connecticut, New York, Virginia, West Virginia, Mississippi, Texas, Oklahoma, and Kansas.

Gymnosporangium juniperi-virginianae Schw. = (Gymnosporangium macropus Lk.)
Connecticut (JLS), Pennsylvania, Maryland (JFC), Virginia (JFC), Ohio - considerable in some localities, the disease is recognized to be confined to southern Ohio (RCT), and Minnesota.
Reports to Plant Disease Survey in previous years from Massachusetts, Connecticut, New Jersey, New York, Pennsylvania, Delaware, West Virginia, South Carolina, Alabama, Oklahoma, Ohio, Illinois, Minnesota, Iowa, Nebraska, and Kansas.

Gymnosporangium nelsonii Arth.
Utah

Gymnosporangium nidus-avis Thaxt.
Found in Massachusetts, New York, and Nebraska.

Gymnosporangium spp.
Massachusetts, Colorado.

Blight caused by Pestalozzia funerea Desm.
Illinois

Blight caused by Pestalozzia sp.
Michigan

Nursery blight caused by Phoma sp.
Rhode Island, Pennsylvania, (JFC)
Indiana - local, moderate amount of damage. (HET)

PINE (Pinus attenuata)
Lodgepole pine mistletoe caused by Razoumofskya americana (Nutt.) Kuntze
Reported from Oregon

PINE, AUSTRIAN (Pinus austriaca)
Rust caused by Cronartium sp.
Ohio, Nebraska

Canker caused by Nectria cucurbitula Sacc.
Pennsylvania - local, severe; a number of trees on an estate badly

damaged. (CMS)

Twig blight caused by Physalospora cydoniae Arnaud
Connecticut

Dieback caused by Diplodia sp.
New Jersey

Winter injury and killing
Connecticut, Kansas

Blight - cause unknown
Pennsylvania - Fernhill Park, Germantown, Philadelphia, June 6, about one third of a planting of young Austrian pine were affected, the young leaves had a burnt appearance. (AM)

Macrosporium sp.
New Jersey (JFC)

Mycosphaerella tulasnei Jacz.
New Jersey (JFC)

Thelephora laciniata Pers.
Rhode Island (JFC)

PINE, LODGEPOLE (Pinus contorta)

Brown trunk rot of the heart wood caused by Fomes officinalis Fr. = Fomes laricis (Jacq.) Murr.
Oregon (JSB)
Probably found throughout range of host, aggregate loss small. (JSB)

Red brown butt rot of the heartwood caused by Polyporus schweinitzii Fr.
Oregon (JSB)
Probably found throughout range of host. Infected trees are often broken off near the ground level by wind, aggregate loss small. (JSB)

Rust caused by Cronartium cerebrum (Pk.) Hedgc. & Long
Idaho

Western pine gall rust caused by Cronartium harknessii (Moore) Meinecke
Washington - San Juan Island (SMZ)
Oregon - both galls and small witches brooms are formed as the result of infection between Emigrant Camp and Summit. (JSB)

Fusiform galls caused by Cronartium filamentosum (Pk.) Hedgc. & Long
Oregon - occasional (JSB)
Probably occurs throughout range of host but not as destructive as C. harknessii (JSB)

Rust caused by Cronartium pyriforme (Pk.) Hedgc. & Long
Montana

Rust caused by Cronartium comptoniae Arth.
New Hampshire

Needle cast caused by Lophodermium pinastri (Schrad.) Chev.
Oregon (JSB)
Causes premature shedding of infected needles and reduces increment of heavily infested trees. Very widespread. (JSB)

Needle blight caused by Hypoderma sp.
Oregon - infected needles die. (JSB)

Blight caused by Neopeckia coulteri (Pk.) Sacc.
Oregon (JSB)
Found only at high elevations. Twigs and small branches near ground die, due to death of needles. (JSB)

Lodgepole pine mistletoe caused by Razoumofskya americana (Nutt.) Kuntze
Washington - quite common on Mount Constitution, Orcas Island, as well as on eastern slopes of the Olympic Mountains. (SMZ)
Oregon (JSB)
Throughout range of host, widespread and does considerable damage, causing the formation of huge witches brooms on trees attacked and greatly reduces their rate of growth. (JSB)

PINE, JACK (Pinus divaricata)

Rust caused by Cronartium cerebrum (Pk.) Hedgc. & Long
Minnesota

Cronartium comptoniae Arth.
Minnesota

Cronartium pyriforme (Pk.) Hedgc. & Long
Minnesota

Peridermium sp.
Wisconsin

Parchment pore fungus rot caused by Polystictus pergamenus Fr.
Minnesota

Needle cast caused by Lophodermium sp.
Minnesota, Wisconsin

Root gall caused by Fusarium ? (sp.)
Nebraska

Blight, cause undetermined
Nebraska

Rusts caused by Cronartium cerebrum (Pk.) Hedgc. & Long
Mississippi

Caeoma strobilina Arth.
Mississippi

Coleosporium ipomoeae (Schw.) Burr.
Georgia

Rusts caused by Coleosporium solidaginis (Schw.) Thüm.
Delaware - common; Mississippi.

Coleosporium terebinthinaceae (Schw.) Arth.
Alabama

PINE, SPRUCE (Pinus glabra)
Rust caused by Peridermium minutum Hedgo. & Hunt
Florida

PINE, SUGAR (Pinus lambertiana)
Needle cast caused by Lophodermium pinastri (Schrad.) Chev.
Oregon (JSB)
Common on needles found on the ground and occasionally is weakly parasitic. (JSB)

Merulius brassicaefolius Schw.
Oregon

Damping off probably caused by Pythium debaryanum Hesse
California - very bad in nurseries. (WHi)

PINE, SWISS (Pinus montana var. mughus)
Rust caused by Cronartium comptoniae Arth.
New Hampshire

PINE, WESTERN WHITE (Pinus monticola)
White pine blister rust caused by Cronartium ribicola Fischer
This disease was found in the Pacific Northwest in the fall of 1921. This is the first time the disease has been found in the West. It has been found at several points in the Puget Sound Region of Washington confined to the cultivated black currant (Ribes nigrum), and two infected eastern white pines (Pinus strobus) were located in a nursery at Mt. Vernon, Washington. This is the first serious epidemic forest tree disease that has appeared on the Pacific Coast. Unless this rust can be eradicated or properly controlled, the future of the commercially valuable western white pine and sugar pine becomes very uncertain. (JSB)
More detailed information on this disease is given under Pinus strobus.

Blue stain caused by Ceratostomella pilifera (Fr.) Wint.
Western white pine is extremely susceptible to blue stain of the sapwood when dried even under the best conditions, provided climatic conditions are suitable for development of the fungus; warm days with high humidity promote staining. Can be prevented by immediate kiln drying. (JSB)
Reported also from Idaho.

Sparassis radicata Weir
Reported in Montana, Idaho, Washington, and Oregon.

PINE, BISHOP (Pinus muricata)

Gall fungus,- probably Peridermium harknessii Moore Am. Auct.
California - in native stands and plantations along coast. (WM)

PINE, MARITIME (Pinus pinaster)

A plantation of this species at Chico, California has been dying from one end for several years. This may be due to climatic influences but it looks more like a root disease such as affects "Les Landes" district in France. No evidence of disease is apparent above ground, but all the trees in one half of the plantation have died. The trees are 25 to 30 years old. (WM)

PINE, LONGLEAF (Pinus palustris)

Rust caused by Coleosporium laciniariae Arth.
Florida

PINE, BULL PINE (Pinus ponderosa)

This species is relatively sound and free from decay. It is rarely that the loss in a stand will amount to more than two percent from all species of wood destroying fungi. (JSB)

Heart rot caused by Fomes officinalis Fr.
Oregon - this rot may extend throughout the heartwood. (JSB.
Distributed throughout range of host. (JSB)

Red rot caused by Trametes pini (Brot.) Fr.
Oregon (JSB)
Distributed throughout range of host, also known as ring scale rot. (JSB)

Red brown butt rot caused by Polyporus schweinitzii Fr.
Oregon (JSB)
Distributed throughout range of host. (JSB)

Western pine gall rust caused by Cronartium harknessii (Moore) Meinecke
Washington, Oregon (JSB)
Causes galls and small witches brooms on infected trees. Occasional throughout range of host, kills infected trees or branches thereof and retards growth. (JSB)

Pine- Comandra rust caused by Cronartium pyriforme (Pk.) Hedgc. & Long
Montana, Oregon (JSB), California
Kills young trees. This rust is locally destructive but, due to the fact that the alternate host Comandra is not widespread, the total damage is small.

Pine rust caused by Cronartium comptoniae Arth.
New Hampshire, Michigan, Minnesota.

Pine rust caused by Cronartium cerebrum (Pk.) Hedgc. & Long
Pennsylvania - Greenwood Furnace, Huntingdon County, a large gall 6 inches in diameter, found near the base of a western yellow pine in a pine plantation. (LOO)

Needle cast and witches brooms caused by Hypoderma deformans Weir
Oregon (JSB)

Needle cast caused by Lophodermium pinastri (Schrad.) Chev.
Oregon (JSB)
Distributed throughout range of host. May vary from a weak to quite strong parasitic fungus. The variation depends on climatic conditions and also on the individual susceptibility of infected trees. Causes premature shedding of infected needles, attacks older needles. Increment of infected trees reduced. (JSB)

Pacific Slope yellow pine mistletoe - Razoumofskya campylopoda (Engelm.) Piper
Oregon (JSB)
This mistletoe is widespread. It is a serious parasite. Huge witches brooms and distorted trunks commonly result in large trees while many seedlings and saplings are badly deformed or killed outright. The growth of infected trees is reduced in varying degrees, depending on the severity of infection. (JSB)

Canker caused by Cenangium piniphilum Weir
Montana - western part
Idaho - Lake region of northern part of state, of considerable importance on trees 5-25 years or older, thrives best in moist, dense stands, where reproduction is overcrowded.
Washington - eastern section of state.

Weir, James R. Cenangium piniphilum n. sp. an undescribed canker forming fungus on Pinus ponderosa and P. contorta. Phytopath. 11: 294-296. July 1921.

Seedling blight caused by Cladosporium herbarum Lk.
Nebraska

Damping off caused by Fusarium sp.
New Jersey
District of Columbia

Peridermium sp.
Ohio

Discosia sp.
Nebraska

Polyporus volvatus Pk.
Idaho - severe

Winter killing
New Mexico (JFC)

PINE, YELLOW (Pinus ponderosa scopulorum)
Rust caused by Cronartium cerebrum (Pk.) Hedgc. & Long
Nebraska

PINE, TABLE MOUNTAIN (Pinus pungens)
Rust caused by Cronartium pyriforme (Pk.) Hedgc. & Long = (C. Comandrae Pk.)
Pennsylvania - Charteroak, Huntingdon County, May 30, 1921, found once on a branch of a 15 or 20 year old tree; was fruiting on day found. (LOO)

PINE, MONTEREY (Pinus radiata)
Rust probably caused by Cronartium harknessii (Moore) Meinecke
California - seriously affected with a gall fungus in native stands and plantations along the California coast. (WM)

PINE, RED (Pinus resinosa)
Leaf cast caused by Lophodermium pinastri (Schrad.) Chev.
Minnesota

Red-brown sapwood rot caused by Fomes pinicola (Fr.) Cke.
Minnesota

Pecky wood rot caused by Trametes pini (Brot.) Fr.
Minnesota

Damping-off caused by Pythium debaryanum Hesse
Minnesota

Seedling blight caused by Rhizoctonia sp.
Minnesota

Pitch pine blister rust caused by Coleosporium delicatulum (Arth. & Kern) Hedgc. & Long
Vermont

Needle rust caused by Coleosporium solidaginis (Schw.) Thüm.
Vermont

Blister rust caused by Cronartium comptoniae Arth.
New Hampshire

PINE, PITCH (Pinus rigida)
Rusts caused by Coleosporium laciniariae Arth.
New Jersey

Coleosporium solidaginis (Schw.) Thüm.
Connecticut

Cronartium cerebrum (Pk.) Hedgc. & Long
Pennsylvania

Cronartium comptoniae (Pk.) Hedgc. & Long
Occurs in New Hampshire, Vermont, Massachusetts, New York, and New Jersey. (JFC)

Leaf cast caused by Hypoderma sp.
New Hampshire (JFC)

Leaf cast caused by Lophodermium pinastri (Schrad.) Chev.
Rhode Island
Pennsylvania - Charteroak, Huntingdon County, Jan. 30, locally severe, caused yellowing and casting of leaves, also appeared to cause injury and death to entire spur branches before leaves reached maturity, so that affected leaves were much stunted. Leptostroma stage collected on January 30 and perfect stage, May 1909. (LOO)

Rust caused by Peridermium sp.
Ohio

Pestalozzia funerea Desm.
Massachusetts

PINE, SCOTCH (Pinus sylvestris)
Rust caused by Cronartium comptoniae (Arth.)
New York, Ohio

Colletotrichum sp.
Ohio - severe in seed beds, kills the growing point of seedling, limited to Lawrence County.

Sphaeropsis sp.
Rhode Island (JFC)

Peridermium sp.
Minnesota

PINE, LOBLOLLY (Pinus taeda)
Rusts caused by Coleosporium laciniariae Arth.
Florida

Coleosporium solidaginis (Schw.) Thüm.
New Jersey

Cronartium cerebrum (Pk.) Hedgc. & Long
Louisiana

Cronartium comptoniae Arth.
New Jersey, Georgia

PINE, SCRUB (Pinus virginiana)
Blister rusts caused by Cronartium comptoniae Arth.
Pennsylvania - Stone Valley. A survey of a small area ranging in age up to 30 years, showed 22-1/2% infection. (LOO)

Coleosporium helianthi (Schw.) Arth.
South Carolina

Peridermium sp.
Delaware - most common in Sussex County, very abundant, injures trunk and branch.

PINE, WHITE (Pinus strobus)
White pine blister rust caused by Cronartium ribicola Fischer

STATUS OF WHITE PINE BLISTER RUST CONTROL IN 1921-22
(Prepared by S. B. Detwiler, Office of Blister Rust Control)

Eastern United States

Severe and wide-spread blister rust infection took place in 1919 on white pine in the New England States and New York. Since it requires three years, as a rule, for blister rust cankers to develop, the extent of this damage first became apparent during the early summer of 1921. Sample plot studies indicate approximately 200 percent increase in canker production occurred in 1919. Infection in 1920 was very light. As a result of increasing damage, much interest has been aroused in the protection of pine woodlots from further ravages of the disease. Positive evidence is now at hand that systematic work in destroying wild and cultivated currant and gooseberry bushes is effective in checking the spread of the rust in areas thus treated. Control areas cleared of the secondary hosts of the blister rust in 1916 and 1918 now furnish convincing evidence of the success of local control measures.

The distance to which currants and gooseberries must be removed to safeguard pine stands does not exceed 900 feet under average conditions. Under favorable conditions, no commercial damage to the pines will result if currants are destroyed within 600 feet, while in other cases, notably cultivated black currants, the bushes must be removed to a greater distance than 900 feet. The sporidia of the blister rust remain alive only for a few minutes after they are blown from currant or gooseberry leaves. This, together with the fact that currant and gooseberry plants are less difficult to exterminate than most weeds, are the chief factors contributing to the success of local control of the blister rust. Cultivated black currants are the most heavily infected of all Ribes. They grow tall, usually are located in open spaces exposed to the wind, they have a large leaf surface and retain their foliage very late in the season. In one instance 150 black currant bushes on an exposed hill top infected pines to a distance of 1.7 miles, while 12 infected black currants in a valley, exceptionally well screened, caused very limited infection of pine and for only a few hundred feet.

In 1916, blister rust infection was found generally distributed on Ribes on a line from Cape Cod to Lake George and northward to the Canadian border. From 1917 to 1921, the New England States, New York, Wisconsin, and Minnesota cooperated with the Bureau of Plant Industry in developing practical local control measures. Cooperation between these states and the Federal government is continuing for the purpose of securing the widespread application of control measures. The Bureau of Plant Industry has assigned a number of blister rust agents to work in cooperation with the State Forestry Departments and the State Agricultural Extension Divisions. By this means, pine owners are instructed in the methods of work and the cooperating State agency assists the pine owners to do the work effectively.

BLISTER RUST CONTROL DATA, 1921, IN INFECTED EASTERN TERRITORY

State	No. wild and cultivated currants and gooseberry bushes destroyed.	No. acres cleared of wild currant & gooseberry bushes.	Average cost per acre
Connecticut	41,476	8,000	$0.33
Maine	57,012	156,221	.022
Massachusetts	637,249	32,933	.313
New Hampshire	1,664,156	137,827	.159
Rhode Island	16,574	26,971	.142
Vermont	60,568	6,319	.548
New York	730,587	8,474	2.66
Minnesota	39,773	589	.675
Wisconsin	457,093	8,887	.444
TOTAL	3,704,588	386,221	.187

The low cost of control work in Maine is due to the fact that in the section worked wild currant and goose berry bushes were very few and localized. Consequently large areas were eliminated by advance scouting, as containing no Ribes. The scouts pulled the scattered bushes and marked the Ribes areas for crew work. A total of 152,413 acres were eliminated by the scouts and 3,808 acres worked by the crews. The per acre cost for scouting was only 1.2 cents while the crew work cost forty cents per acre. The average cost for the whole area worked was 2.2 cents per acre.

White pine will continue to be a profitable crop in spite of the ravages of blister rust, because its value is so generally recognized that pine owners seldom fail to act when informed on the situation. In most cases, all that is necessary is to take the pine owner into his woodlot, show him blister rust infection already present, teach him to identify the wild currant and gooseberry bushes, and to systematize the work of uprooting them. The high returns from the white pine growth are sufficient incentive to quick action when the owner realizes the rust is on his pine or nearby, especially when he can be shown pines 7 to 15 inches in diameter that are dead or dying from the disease, as is now the case in a number of localities.

In 1921 the blister rust was found in Pennsylvania on currants and on native pine for the first time in this State. The disease evidently has spread from adjacent infected areas in New York. During the summer of 1922, pine infection has also been found in four localities in Michigan.

Western United States.

The most important development of the year was the discovery of the white pine blister rust in the Pacific Northwest. The original discovery of the rust in the West was made in the Fall of 1921 by Professor J. W. Eastham, Provincial Plant Pathologist of British Columbia. This was on cultivated black currants at Vancouver, B. C. Later, the blister rust was found on cultivated black currants at fifteen or more points on Vancouver Island and the mainland. Professor Eastham found diseased cultivated red currants and cultivated gooseberries at three points in British Columbia but these bushes were infected very lightly and were grown in rows immediately adjacent to heavily infected black currants. An importation of about one thousand white pine seedlings from France to Vancouver, B. C. in 1910 is thought to be the original source of infection. This importation was of course made some years before the establishment of the blister rust quarantine in Canada and the United States. In November, 1921, Dr. Bethel and Mr. Putnam, of the Bureau of Plant Industry, found cultivated black currants infected with white pine

blister rust at Sumas City, Mt. Vernon, Everett, and Port Townsend, Washington. Later, Mr. L. N. Goodding of the Office of Blister Rust Control also found two five-needle pines at Mt. Vernon, Washington, which had blister rust cankers on 1917 wood. Infection apparently took place from adjacent cultivated black currants.

Previous to the above discoveries this disease was not known to occur in any place in North America west of the State of Minnesota. Extensive field surveys during the season of 1922 have shown the following facts:

(1) The white pine blister rust is widespread throughout the coast pine belt of British Columbia on both pines and Ribes.

(2) It occurs on both pines and Ribes at Revelstoke and Beaton east of the dry belt in British Columbia, but has not been found on any host plant nearer than a hundred miles north of the international boundary in this region.

(3) During the summer of 1922 it was found on Ribes in the following counties of western Washington: San Juan, Island, Whatcom, Skagit, King, Pierce, Clallam, Jefferson, Kitsap, Mason, Grays Harbor, and Pacific. The number of localities and number of plants per species is as follows:

Places	Species	No. plants
1	G. divaricata	1
44	R. bracteosum	94
6	Cultivated red	15
106	R. nigrum	709

The disease thus far has not been found on pines in this region except a single canker of 1917 origin at Blaine near the international line in Whatcom County.

<u>Literature</u>

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Spaulding, Perley. Notes on Cronartium ribicola. (Abstract) Phytopath. 12: 46. Jan. 1922.

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PINE, WHITE (Pinus strobus)

Blister rust caused by Peridermium sp.

North Carolina - more prevalent than in previous years.

Leaf cast caused by Hypoderma strobicola Tub.

Pennsylvania - Stone Creek, Huntingdon County - present in a small white pine seeding, apparently only old needles that were about to be shed are attacked, as it was found only on the needles of the previous year's growth; a single needle may be affected and all the cluster may be dead; spores matured in July. (LOO)

Needle cast caused by Lophodermium lineare Pk.

Rhode Island (JFC)

Pennsylvania - Greenwood Furnace, Huntingdon County - found on a few young white pines 12-15 years old, all needles prior to 1920 growth have been shed. Disease noted only on previous year's needles on which the appearance was that the fungus is decidedly parasitic and somewhat destructive; at a distance of a few feet the needles of the previous year have a wilted appearance and are more or less twisted; this fungus is easily distinguished from the other needle cast fungi in that the black apothecia are more or less continuous in lines along the leaf. (LOO)

Needle cast caused by Lophodermium pinastri (Schrad.) Chev.

Pennsylvania - Greenwood Furnace, Huntingdon County - found on five year seedlings at the state nursery, rather severe. (LOO)

Wisconsin

Needle blight - non-parasitic

Maine - There was a rather general turning brown of the white pine trees in the southern part of Maine this year. The injury is characterized by the turning brown of the tips of this year's needles in all parts of the tree. In unusually severe cases, the entire needle, both in this and previous years' growth is affected and the tree dies. Ordinarily, however, recovery without any appearance of permanent injury seems more common. The trouble is very similar to that which caused a good deal of alarm in 1907 and 1908 and was referred to at that time as the 'white pine blight.' There is no sign of disease or insects and the present trouble is apparently entirely physiological. (STD)

Connecticut - very prevalent.

"Needle blight" of Pinus strobus has been reported by the Forest Service and by lumbermen many times from 1905 onward. Investigations were begun in 1918. The disease manifests itself as a reddening of the new needles and has been so abundant that certain pine areas have assumed an autumnal coloration in midsummer. The trouble has been variously ascribed to winter injury, late frosts, insects, fungi, etc., and has been confused with winter browning and sulfur fumes injury. It has been discovered that it begins with a killing of the roots, apparently due to a combination of soil peculiarities and drought conditions, hence the root system is not able to supply the sudden demand for water made by the new foliage. Repeated blighting results in the death of affected trees. Hundreds of trees were examined in 1918 and tagged with serially numbered metal disks. Out of 275 healthy trees 2 have since developed blight and under exactly known conditions. Out of 147 trees 6 inches in diameter or less 7 percent have died. Out of all trees over 6 inches in diameter 23.7 percent have died. The results so far show that young stands for the most part recover, but that mature stands are seriously injured. (JHF)

Faull, J. H. Records for four years on the needle blight of Pinus strobus (Abstract) Phytopath. 12: 58. January 1922.

__________ Some problems of forest pathology in Ontario. Needle blight of white pine. Jour. For. 20: 67-70. Jan. 1922.

Chemical injury

"During the summer of 1921 two non-parasitic troubles of the white pine came under observation. In one case in Massachusetts a lot of 25 to 30 acres of white pines, which appeared from a distance to be totally dead, were found to be still alive, but only the basal portions of the needles were living. Gases from the chimney of a brick kiln about 1/4 mile north were suspected as the cause of the damage. A checking of the weather records, with the dates of burning of the kiln, substantiated the suspicions that such gases (probably SO_2) caused the trouble. Another case of the death of pine trees was along the roadside in New Hampshire. It was found that barrels of calcium chloride for application to the road had been stored under these trees and the salt which seeped into the soil had killed the pines and partially defoliated the elms and birches nearby." (Snell, Walter H. and N. O. Howard. Chemical injuries to white pines. (Abstract) Phytopath. 12: 59. Jan. 1922

Armillaria mellea (Vahl.) Quel.
New Hampshire (JFC)

Calicicopsis pinea Pk.
Maine (JFC)

Capnodium pini B. & C.
Connecticut (JFC)

Capnodium sp.
New York (JFC)

Cenangium ferruginosum Fr.
Ohio

Coccomyces sp.
Maine (JFC)

Corticium vagum B. & C.
Minnesota

Fusicoccum sp.
New Hampshire (JFC)

Fusoma parasiticum Tub.
Minnesota

Nectria cucurbitula (Tode) Fr.
Vermont

Nectria sp.
Wisconsin (JFC)

Phacidium crustaceum B. & C.
Rhode Island (JFC)

Phoma sp.
New Hampshire (JFC), Connecticut, Wisconsin (JFC)

Physalospora sp.
Pennsylvania - apparently the fungus described by Clinton as a Phoma; produces basal canker on planted white pine, such trees are easily detected by the yellowish cast of the foliage as stated by Clinton, works slowly but eventually results in the death of the tree. (LOO)

Rhizoctonia sp.
Massachusetts
Connecticut
Minnesota

Winter killing
Maine, Massachusetts, Connecticut, Pennsylvania

Leaf scorch
Massachusetts, Connecticut, Michigan

Ectotrophic mycorrhiza
Pennsylvania - slow death of trees showing much stunted needles and perhaps attributed to ectotrophic mycorrhiza, very common, considerable loss. (LOO)
Ohio

PINES (Pinus spp.)
Cenangium ferruginosum Fr.
Ohio

Cladosporium sp.
New York, West Virginia, Indiana, (JFC)

Coleosporium solidaginis (Schw.) Thüm.
New York, New Jersey, Georgia, and Minnesota.

Cronartium cerebrum (Pk.) Hedgc. & Long
Maryland and Georgia

Cronartium comptoniae Arth.
New Jersey and Pennsylvania

Cronartium filamentosum (Pk.) Hedgc. & Long
Washington

Cronartium pyriforme (Pk.) Hedgc. & Long
Connecticut, New Jersey, and Pennsylvania

Diplodia pinea Kickx.
New Jersey (JFC)

Fusarium spp.
Vermont, New York (JFC), Pennsylvania, Illinois, Missouri and Nebraska.

Gallowaya pini (Galloway) Arth.
New Jersey and North Carolina

Hendersonia foliicola Fckl.
District of Columbia

Lophodermium brachysporium Rostr.
New Jersey

Lophodermium pinastri (Schr.) Chev.
Pennsylvania - Huntingdon County - seems most severe on Pinus rigida in vicinity of Charteroak, causing yellowing and casting of leaves; also appears to cause injury and death to entire spur branches before leaves reach maturity. Leptostroma stage collected Jan. 30. Perfect stage May 29. (LOO)
Washington

Lophodermium sp.
Pennsylvania

Mycosphaerella tulasnei Jacz.
New Hampshire (JFC)

Naemacyclus niveus (Pers.) Fckl.
Colorado - just present

Peridermium sp.
Washington

Pestalozzia sp.
New York (JFC), Pennsylvania

Polyporus osseus Kloh.
Massachusetts (JFC)

Razoumofskya americana (Nutt.) Kuntze
Found in Idaho, Oregon, and California

Razoumofskya campylopoda (Engelm.) Piper
Oregon

Razoumofskya sp.
Washington

Rhizoctonia sp.
Maine, Idaho

Scorias spongiosa (Schw.) Fr.
Massachusetts

Septoria parasitica Hart.
Pennsylvania

Winter injury
Maine, New York (JFC), New Jersey, Pennsylvania & Ohio

Drought
Massachusetts (JFC)

Sun scorch
Massachusetts, New York

Leaf blight - physiological
North Carolina

Undetermined Diseases

Root rot (Ohio), blight (Maine, Vermont, and Rhode Island), seedling blight (Nebraska), Damping off (Iowa), and heart rot (Massachusetts (1916 JFC).

SEQUOIA (Sequoia washingtoniana)
New disease - cause undetermined
California - a planted stand of these trees at Chico, which had grown splendidly up to 25 years old, has been dying for the past five years, the first evidence of the disease is a brownish appearance of the lower crown which gradually ascends until the whole crown is dead, the process takes from six months to a year. So far about one third of the trees have died at irregular intervals throughout the plantation. The trees average 75-100 feet high and 12 to 20 inches, diameter breast high. (WM)

Seedling rot caused by Botrytis douglassi Tub.
Ohio

Cercospora sequoiae Ell. & Ev.
District of Columbia (JFC)

SPRUCE, ENGELMANN (Picea engelmannii)
Stringy brown rot caused by Echinodontium tinctorium Ell. & Ev.
Oregon (JSB)
Causes a heartrot in living trees, aggregate damage small. (JSB)

Spruce needle cast caused by Lophodermium sp.
Oregon - causes premature shedding of infected needles, attacks older needles. (JSB)

Blight caused by Herpotrichia nigra Hart.
Oregon - found occasionally at high elevations, kills twigs and branches near ground. (JSB)

Leaf rust caused by Chrysomyxa weirii Jack.
Idaho - importance slight, found only on Engelmann spruce from 2 to 3 inches in diameter.
Oregon

Yellow root rot caused by Sparassis radicata Weir
Occurs in Montana, Idaho, Washington, and Oregon.

SPRUCE, NORWAY (Picea excelsa)
Spruce phoma caused by Phoma chonophila Sacc.
Ohio

SPRUCE, BLACK (Picea mariana)
Witches' broom caused by Razoumofskya pusilla Pk. = (Arceuthobium pusillum)
Massachusetts

Rust caused by Melampsoropsis abietina (Alb. & Schw.) Arth. = (Peridermium abietinum)
Michigan

Heartwood rot caused by Trametes pini (Brot.) Fr.
Minnesota

SPRUCE, BLUE (Picea parryana)
Rust caused by Peridermium sp.
Utah

SPRUCE, SITKA (Picea sitchensis)
Spruce needle cast caused by Lophodermium sp.
Washington (JSB)
Attacks older needles and causes premature shedding. (JSB)

Heartwood rot caused by Trametes pini (Brot.) Fr.
Washington (JSB)
This fungus causes the most extensive decay of all wood destroying fungi in spruce stands. Probably found throughout range of the host. (JSB)

Red-brown butt rot of heartwood caused by Polyporus schweinitzii Fr.
Washington (JSB)
The work of this fungus was particularly noticeable in the wind thrown timber in the Olympic storm zone, sound trees had been uprooted while those with butt rot had been broken off near the ground. (JSB)

SPRUCE (Picea spp.)
Rusts caused by Chrysomyxa rhododendroni (DC.) De Bary
Massachusetts

Coleosporium solidaginis (Schw.) Thüm.
Minnesota

Melampsoropsis ledicola (Pk.) Arth.
Washington

Spruce needle-cast caused by Lophodermium sp.
New Hampshire (JFC)

Phoma sp.
Pennsylvania, Virginia (JFC)

Witches broom - cause unknown
Washington

Leaf scorch
New York, Kansas

Drought
New York - probably common

YEW, WESTERN (Taxus brevifolia)
Needle blight caused by Mycosphaerella taxi Cke.
Washington, Oregon. (JSB)
Kills infected needles. (JSB)

DISEASES OF HARDWOODS

ALDER, MOUNTAIN (Alnus tenuifolia)
Powdery mildew caused by Phyllactinia corylea (Pers.) Karst.
Oregon - caused little or no damage. (JSB)

ALDER, RED (Alnus oregona)
Catkin deformation caused by Exoascus tosquinetii Sacc.
Oregon (JSB)

Powdery mildew caused by Phyllactinia corylea (Pers.) Karst.
Oregon - on leaves, little or no damage. (JSB)

Leaf spot caused by Septoria alni Sacc.
Oregon - little or no damage. (JSB)

ALDER (Alnus spp.)
Leaf spot caused by Cylindrosporium vermiforme Davis.
Pennsylvania - Bear Meadows - first collection of this unique species. (LOO)

Leaf spot caused by Leptothyrium alneum (Lev.) Sacc.
Pennsylvania - on Alnus rugosa, Bear Meadows; caused a moderate amount of damage, formed discolored areas instead of definite spots. (LOO)

Catkin deformation caused by Exoascus tosquinetii Sacc. = (Exoascus amentorum Sadeb.)
Idaho - common on the catkins of alders growing around Payette Lake.

Mycorrhiza
Washington

Winter injury
Washington

Root galls, cause undetermined
Washington - in western part of state, probably crown gall, large galls similar to those on other plants.

ASH, MOUNTAIN (Pyrus sitchensis)
Rust caused by Gymnosporangium nootkatensis (Trel.) Arth.
Washington - the telia occur on the leaves of Alaska Cedar (Chamaecyparis nootkatensis), causes slight injury to the leaves. (JSB)

ASH, AMERICAN MOUNTAIN (Pyrus americana)
Fruit rot and canker caused by Glomerella sp.
Indiana - local, causing slight damage, produces a rot of the berry and a canker on the branches. (HET)

Canker caused by Physalospora cydoniae Arnaud
Indiana - canker on main stem of tree which was girdled, death resulted. (CMS)

ASH, OREGON (Fraxinus oregona)
Leaf blight caused by Cylindrosporium californicum Earle
Oregon - when severe it causes a premature browning of the leaves. (JSB)

Leaf blotch caused by Phyllosticta viridis E. & K.
Oregon (JSB)

ASH (Fraxinus spp.)
Leaf spot caused by Cercospora fraxinites Ell. & Ev.
Texas - trace, unimportant.
Only report to this office to date of the occurrence of this disease in the United States.

Rust caused by Puccinia peridermiospora (Ell. & Tracy) Arth. = (P. fraxinata (Lk.) Arth. and Aecidium fraxini)
New Hampshire - first report to Plant Disease Survey from this state.
Minnesota - on leaf and twig, unimportant,-in former years has been reported from Massachusetts, Connecticut, New York, Delaware, Maryland, Virginia, Ohio, Wisconsin, Minnesota, Iowa, North Dakota, and Nebraska.

Leafspot caused by Septoria fraxini Desm.
Minnesota - local in state, unimportant.
Has also been found in Michigan.

ASPEN (Populus tremuloides)
White heartwood rot caused by Fomes igniarius (L.) Fr.
Maine (STD)

BEECH (Fagus atropunicea)
White heartwood rot caused by Fomes igniarius (L.) Fr.
Maine (STD)

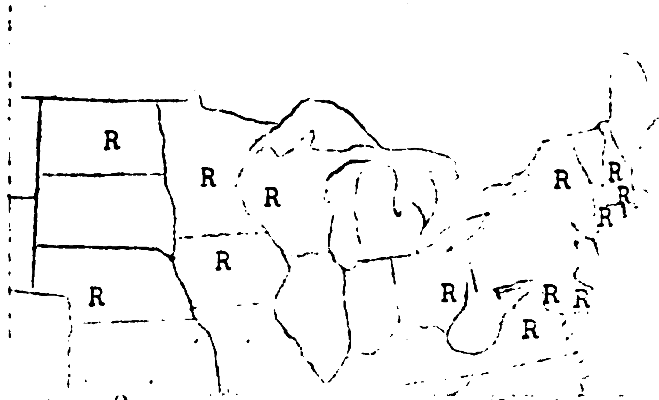

Fig. 85. Geographical distribution of ash rust in the U. S. as reported to the Plant Disease Survey.

BIRCH (Betula spp.)
Canker caused by Melanconium betulinum Schm. & Kze.
Ohio - first appearance in state. (RCT)

White streaked sapwood rot caused by Pleurotus ostreatus Jacq.
Maine (STD)

White heartwood rot caused by Fomes igniarius (L.) Fr.
Idaho - quite common on B. occidentalis)

Wood rot caused by Pycnoporus cinnabarinus Karst. = (Polystictus cinnabarinus) (Jacq.) Fr.)
Washington

Witches broom - cause unknown
Washington

Drought injury caused by extremely dry hot weather.
New York - a few trees were injured or killed, especially where the birches were planted in filled-in lawns.

BUCKEYE (Aesculus glabra)
Leaf blotch caused by Guignardia aesculi (Pk.) Stewart = (Phyllosticta paviae Desm., P. sphaeropsidea Ell. & Ev.)
Ohio - period of greatest injury was during July and August when the host was in full leaf, of considerable importance and becoming more prevalent, all species of Aesculus are apparently susceptible.
Iowa - average amount of prevalence, trace of loss.

BUCKTHORN (Rhamnus spp.)
Rust caused by Puccinia coronata Cda.
Connecticut (JLS)
New York - much more prevalent than in previous years.
Illinois - especially prevalent in northern part of state.

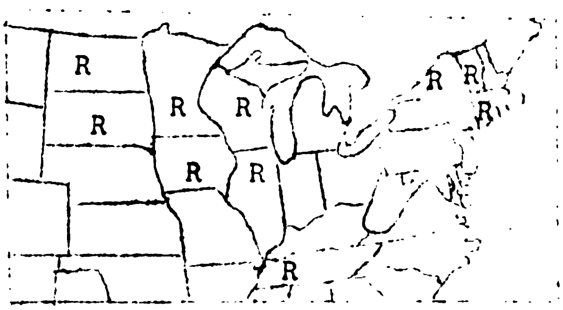

Fig. 86. Distribution of crown rust of buckthorn in the U. S. as reported to the Plant Disease Survey

BUTTERNUT (Juglans cinerea)

Anthracnose caused by Gnomonia leptostyla (Fr.) Ces. & De Not. = (Marssonia juglandis (Lib.) Sacc.) (Gloeosporium juglandis (Lib.) Mont.)

New York - probably found wherever butternut grows in state, was severe on many trees.

Pennsylvania - leaves yellowing and dying, fungus fruiting nicely. (LOO)

Illinois - prevalence same as preceding years.

Iowa - unimportant during 1921.

Leaf spot caused by Microstroma juglandis (Ber.) Sacc.

Pennsylvania - rather common but not severe. (LOO)

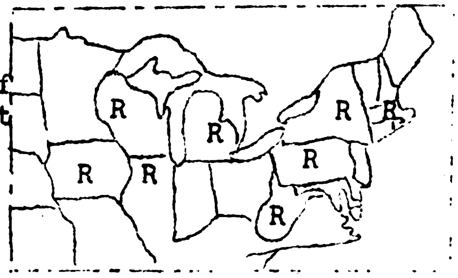

Fig. 87. Distribution of anthracnose of butternut in the U. S. as reported to the Plant Disease Survey.

CAMPHOR (Cinnamomum camphora)

Anthracnose caused by Gloeosporium camphorae Sacc.

Texas - not important, trace.

CATALPA (Catalpa spp.)

Leaf spot caused by Macrosporium catalpae E. & M.

Connecticut - two reports of occurrence during year.

Indiana - not common.

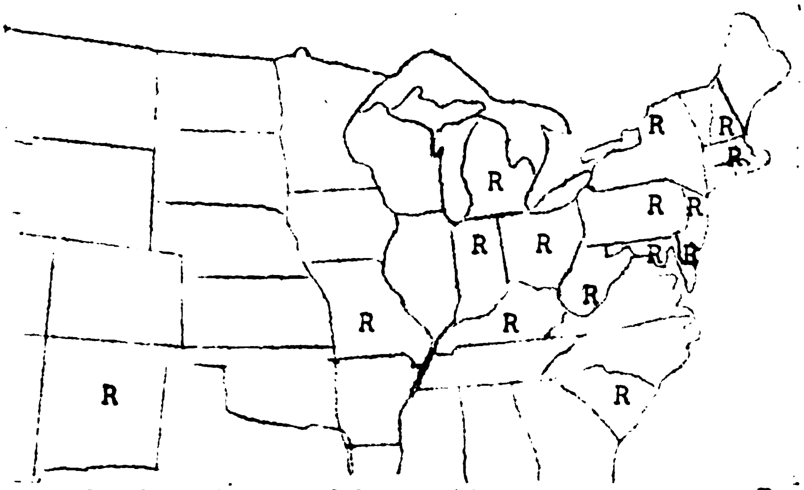

Fig. 88. Distribution of Phyllosticta leaf spot of the catalpa in the U. S. as reported to the Plant Disease Survey

Leaf spot caused by Phyllosticta catalpae E. & M.

New York - not important during present year.

Ohio - a moderate amount was general in distribution, causing defoliation; first reported appearance July 18, greatest amount of injury occurred during July when the host was in full leaf, weather favorable to the disease.

Control measures suggested by Dr. Freda Detmers, Ohio Agricultural Experiment Station as follows: "First, the sanitary one of burning fallen infected leaves and second, spraying with Bordeaux mixture (4-6-50

strength), after the leaves have unfolded and again if the spots appear. It may be necessary to repeat the application two or three weeks later." Plant Diseases in Ohio for 1921. Ohio Agr. Exp. Sta.-Ohio State University, page 45.

Powdery mildew caused by Microsphaera alni vaccinii (Schw.) Salm.
Ohio - local

Heartwood rot caused by Polystictus versicolor (L.) Fr.
Ohio - undoubtedly very much more common than reported and causes serious damage to the tree by rotting out the heartwood.

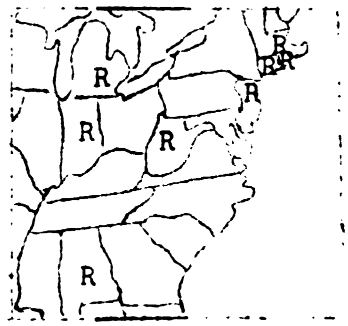

Fig. 89. Distribution of the Macrosporium leaf spot of the Catalpa in the U. S. as reported to Plant Disease Survey.

CATCLAW (Bigonia unguis - cati)
Rust caused by Ravenelia versatilis (Pk.) Diet.
Arizona.

CHERRY, WESTERN CHOKE (Prunus demissa)
Leaf blister caused by Taphrina cerasi (Fckl.) Sade.
Washington - rare. (JSB)

CHESTNUT (Castanea dentata)
Blight caused by Endothia parasitica (Murr.) And.
(Prepared by G. F. Gravatt, Office of Forest Pathology)

"During 1921 the chestnut blight continued its steady spread. In North Carolina the disease was found in five new counties - Rockingham, Forsyth, Iredell, Burke, and McDowell, making a total of thirteen infested counties in that state. In Virginia it was reported from one new county - Craig - and in West Virginia from one new county - Upshur. In all infested areas examined the percent of infected and dead trees increased during 1921. Newspaper reports of the chestnut blight becoming less virulent and of the chestnut stand coming back have so far as investigated proved to be without foundation.

"Two reports of chestnut blight in Indiana sent in by the Department of Conservation, Indianapolis, to the Plant Disease Survey are interesting as a warning to uninfested states with chestnut interests. In one case the blight was found on a nursery tree from Michigan, a state supposed to be free from the disease. On tracing back the source of this infected tree, it was found to have been grown in an old infested nursery in Ohio and had simply been reshipped by the Michigan nursery. In the other case the blight was found in an Indiana chestnut orchard. Chestnut orchards located outside of the native range of the chestnut are liable to become infected from chestnut trees as grown in nurseries within the blight area."

Anthracnose caused by Gloeosporium sp.
Connecticut

Powdery mildew caused by Phyllactinia corylea (Pers.) Karst.
Indiana - moderately severe.

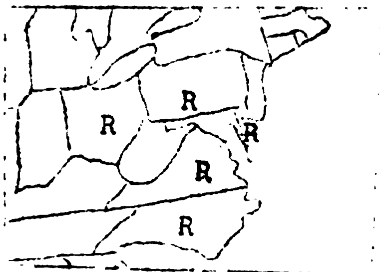

Fig. 90. Geographical distribution of powdery mildew of chestnut in the U. S. as reported to the Plant Disease Survey.

Leaf spot caused by Marssonia ochroleuca E. & C.

Although no reports were received of its occurrence during 1921, it might well have occurred in Maine, Massachusetts, New York, New Jersey, Delaware, West Virginia, North Carolina, and Ohio, as it has been reported from the above states in previous years.

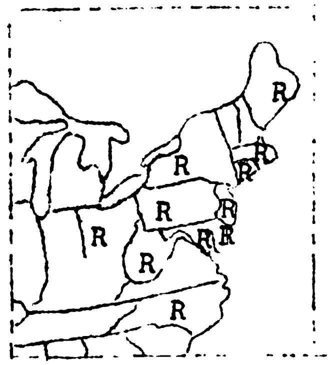

Fig. 91. Geographical distribution of leaf spot of chestnut caused by Marssonia ochroleuca E. & C., in the U. S. as reported to the Plant Disease Survey.

CHINQUAPIN, WESTERN (Castanopsis chrysophylla)

Leaf spot caused by Scirrhia sp.

Oregon - quite common in western Oregon. (JSB)

Probably occurs in Washington. (JSB)

CRAB APPLE, WILD (Pyrus diversifolia)

Rust caused by Gymnosporangium nootkatensis (Trel.) Arth.

Washington - the telia occur on the leaves of Alaska cedar (Chamaecyparis nootkatensis). (JSB)

DOGWOOD (Cornus canadensis)

Leaf rust caused by Puccinia porphyrogenita Curt.

Washington (JSB)

DOGWOOD (Cornus nuttallii)

Powdery mildew caused by Phyllactinia corylea (Pers.) Karst.

Oregon - on leaves is locally quite abundant but causes little apparent injury to the host. (JSB)

DOGWOOD (Cornus sp.)

Leaf spot caused by Cryptomyces maximus (Fr.) Rehm.

Indiana - local, caused very little damage. (HET)

ELDER (Sambucus canadensis)

Powdery mildew caused by Microsphaera grossulariae (Wallr.) Lev.

Ohio

ELM (Ulmus spp.)

Anthracnose caused by Gnomonia ulmea (Schw.) Thum.

New Hampshire

Connecticut - more prevalent than during average year.

South Carolina

Texas - trace, unimportant.

Ohio - greatest damage during midsummer when host is in full foliage moisture and temperature favorable to disease during season.

Indiana - found over state, moderate amount of damage noticed in a nursery. (HET)

Illinois - throughout state, not important during 1921.

Kansas - moderately severe.

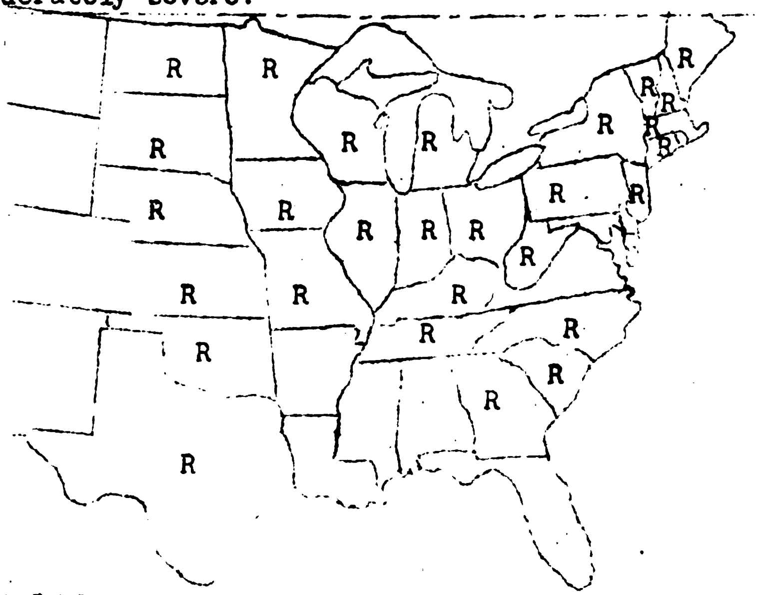

Fig. 92. Geographical distribution of anthracnose of the elm in the U. S. as reported to the Plant Disease Survey.

New York - found in state wherever elms are grown, earliest report in July, only certain trees are badly affected, the branches may intertwine with other elm trees that are wholly free from disease.

Kilian, Charles. Le developpement du Dothidella ulmea (Duv.) Winter. Rev Gen. Bot. 32: 534-551. Pl. 16-19. Dec. 1920. No. 384 Index bibliographique: p. 551.

Powdery mildew caused by Uncinula macrospora Pk.

Ohio - usually found on elms throughout state. (BF)

Root rot caused by Ozonium omnivorum Shear

Texas - prevalent, causes about 1% reduction in the state.

Twig blight caused by Poronidulus conchifer (Schw.) Murr.

Ohio - greatest injury during growing season, produces a defoliation and a death of the twigs, more prevalent than during past years and becoming more important.

Slime flux caused by bacteria, yeasts, etc.

Connecticut, New York.

Canker caused by Sphaeropsis ulmicola Ell. & Ev.
Wisconsin - throughout the southeastern part of state, prevalence increasing, becoming an important disease of the shade tree, may affect the tree at any time or age, starts in nurseries, may be stimulated by injuries.

GUM, COTTON (Nyssa aquatica)
Rust caused by Aplopsora nyssae (Ell. & Tr.) Mains = (Uredo nyssae Ell. & Tr.)
Kentucky (EBM), Mississippi (EBM)

HACKBERRY (Celtis occidentalis)
Powdery mildew caused by Sphaerotheca phytoptophila Kell. and Swing.
Ohio - on witches broom. (BF)
Also reported found in Indiana, Illinois, Missouri, Iowa, and Kansas. (Salmon: Monograph of the Erysiphaceae)

Powdery mildew caused by Uncinula parvula Cke. & Pk.
Ohio (BF)
Also reported from Maine, Vermont, Massachusetts, New York, Pennsylvania, South Carolina, Alabama, Ohio, Michigan, Indiana, Illinois, Wisconsin, Iowa, and Missouri. (Salmon: Monograph of the Erysiphaceae)

Smothering disease caused by Thelephora retiformis
Texas - trace

HAWTHORN (Crataegus douglasii)
Rust caused by Gymnosporangium blasdaleanum (D. & H.) Kern
Oregon - cluster-cups are sometimes found on the leaves. (JSB)

HAWTHORN (Crataegus spp.)
Canker caused by Physalospora cydoniae Arnaud
Indiana - local occurrence, trace of damage. (HET)

Fire blight caused by Bacillus amylovorus (Burr.) DeT.
Washington

Cockayne, A. H. Fire blight and its control. The hawthorn question. New Zealand Journal of Agriculture 23: 30-36, July 1921. No. 1.

Powdery mildew caused by Phyllactinia sp.
Washington

Rust caused by Gymnosporangium globosum Farl.
New Hampshire

Rust caused by Gymnosporangium germinale (Schw.) Kern = (Roestelia aurantiaca Pk.)
Connecticut
Rust caused by Gymnosporangium sp.
Missouri - very common locally.

HAZELNUT (Corylus californica)

Leafspot caused by Gnomoniella coryli (Batsch.) Sacc.
Washington (JSB), Oregon (JSB)
Little injury to host. Probably present occasionally wherever hazelnut occurs in the above two states. (JSB)

Leafspot caused by Septoria corylina Pk.
Washington (JSB), Oregon (JSB)
Probably found in western Washington and Oregon throughout range of host. Where the disease is severe, infected leaves become very much wrinkled and shriveled. (JSB)

HICKORY (Hicoria sp.)

Anthracnose caused by Gnomonia caryae Wolf = (Gloeosporium caryae E. & D.)
Illinois - moderately severe

Leafspot caused by Microstroma juglandis (Ber.) Sacc.
Pennsylvania - Seven Mountains, June 23; observed at the same time on Juglans cinerea but it seemed to be much more severe on the hickory, causing dead areas, the leaves were more or less curled or twisted. (LOO)

HOP TREE (Ptelea trifoliata)

Rust caused by Puccinia windsoriae Schw.
Illinois - general on native trees of this host around Hillview, Pike County.

HORNBEAM (Ostrya virginiana)

Leafspot caused by Gloeosporium robergiae var. dendriticum Davis
Pennsylvania - produces a moderate amount of damage. (LOO)

HORSE CHESTNUT (Aesculus hippocastanum)

Leaf blotch caused by Guignardia aesculi (Pk.) Stewart = (Phyllosticta paviae Desm.) (Phyllosticta sphaeropsidea Ell. & Ev.)
Connecticut (Aug. 15) - average amount.
New York - very common and severe wherever horse chestnuts are grown.
New Jersey - abundant, though less prevalent than in 1920.
Virginia - general over state.
Ohio (July 19) - general over state, serious and becoming more prevalent, period of greatest injury was in August when in full leaf.
Illinois - becoming worse; most destructive disease of host in state, general in range throughout state.
Utah - reported from two districts in the state; this appears to be the first appearance of this disease in Utah.

Powdery mildew caused by Uncinula flexuosa Pk.
Ohio - confined to species of Aesculus and little known in state. (RF)

Leaf spot caused by Monochaetia desmazierii Sacc.
Indiana - infestation local and slight. (HLT)

LINDEN (Tilia spp.)

Leaf spot caused by Cercospora microsora Sacc.
Indiana - local, very slight damage. (HET)

Powdery mildew caused by Uncinula clintonii Pk.
Ohio - rarely seen, previously reported from two localities in Ohio on Tilia americana to which it may be confined in America. (JF)

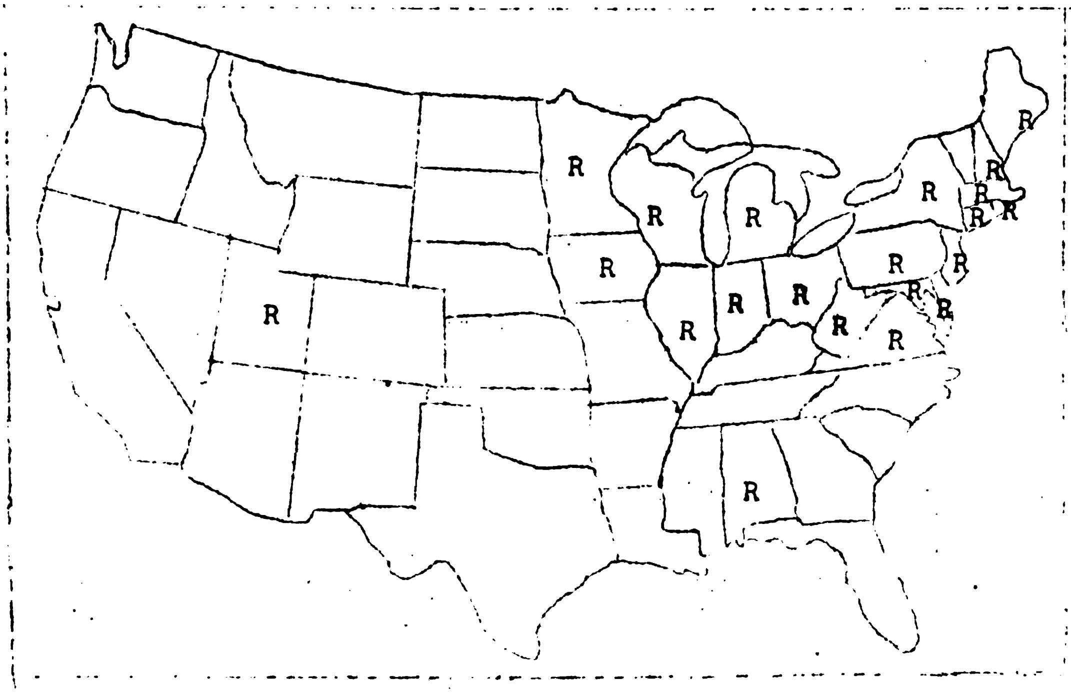

Fig. 93. Distribution of Guignardia aesculi (Pk.) Stewart on horse chestnut in the U. S., according to reports received by the Plant Disease Survey.

Leaf spot caused by Phyllosticta tiliae Sacc. and Speg.
Pennsylvania - a moderate amount of damage. (LOO)

Sun scorch
Connecticut

LOCUST (Robinia pseudacacia)

Yellow wood rot caused by Fomes rimosus Berk.
Oklahoma

MADRONA (Arbutus menziesii)

Leaf spot caused by Mycosphaerella arbuticola Pk.
Oregon - probably widespread in western and southern Oregon, causes little damage. (JSB)

MAGNOLIA (Magnolia sp.)

Anthracnose caused by Colletotrichum sp.
South Carolina - unimportant.

MAPLE, BROAD LEAF (Acer macrophyllum)

Black speckled leaf spot caused by Rhytisma punctatum (Pers.) Fr.
Washington, Oregon. (JSB)
This disease is relatively common and widespread over the range of the host in the Washington-Oregon district, but of no importance. (JSB)

Rot caused by Hydnum sp.
Oregon (JSB)

MAPLE, DWARF (Acer glabrum)

Leaf spot caused by Septoria acerina Pk.
Oregon (JSB)

MAPLE, VINE (Acer circinatum)

Leaf spot caused by Septoria circinata Ell. & Ev.
Washington (JSB), Oregon (JSB)
This disease is apparently widespread in western Washington and Oregon. Does not injure leaves severely. (JSB)

MAPLE (Acer spp.)

Tar leaf spot caused by Rhytisma acerinum Fr.
Connecticut - not bad.
Pennsylvania - central part of state, first noticed June 23 when small spots appeared on seedling of Acer rubrum, some spots bearing the first beginnings of the black stroma; easily distinguished at this stage from the Phyllosticta spot which is brown and not yellow from the first, while tar spot is a rich cream color until the formation of the stroma. (LOO)
South Carolina - on nursery stock.
Ohio
Illinois - general throughout state.
Minnesota - throughout state wherever maple is found, unimportant.

Black specked leaf spot caused by Rhytisma punctatum Fr.
Indiana - generally prevalent but causing very slight damage. (HET)
Orange County: on forest saplings. (WWG)
Illinois, Idaho

Tar spot caused by Rhytisma sp.
Washington - common on maples in woods of western Washington.

Phyllosticta leaf spot caused by Phyllosticta minima (B. & C.) Ell. & Ev.
Pennsylvania - on A. pennsylvanica, Seven Mountains, moderate amount of damage; on A. negundo, State College, Center County, June 28.
Ohio

Leaf spot caused by Gloeosporium apocryptum Ell. & Ev.
New Hampshire
Ohio - prevalent throughout eastern and northern portion of state.

Wilt caused by Verticillium sp.
(Prepared by G. F. Gravatt, Office of Forest Pathology)
"Found in Maryland, District of Columbia, West Virginia, Virginia, North Carolina, Tennessee, and Indiana. This fungus seems to cause a serious disease of the ornamental maples and further work is under way. The disease is probably distributed over the eastern United States as it was found in each locality where a careful search was made."

Virginia - quite generally distributed in state, especially on Norway and Silver maples, also noted by C. M. Scherer and G. F. Gravatt in May.
Indiana (HET)

Powdery mildew caused by Uncinula circinata Cke. & Pk.
Ohio (BF)

White butt rot caused by Fomes applanatus (Pers.) Wallr.
Maine (STD)

Leaf spot caused by Cladosporium humile Davis
Pennsylvania - noted only on a few trees and only late in summer, severe.

Canker caused by Schizophyllum commune Fr.
Oklahoma - growing on pruned trees in a dying condition.

Fumago vagans
Connecticut - no damage except unsightliness, following in honey dew of insects.

Erinose
Washington - local.

Sun or leaf scorch
Connecticut - less than in the average year.
New York - severe on many shade trees on lawns and street, more prevalent than in 1920, weather conditions which prevailed were a dry mid-summer and a high temperature.
Indiana - local and slight. (HET)

"During the spring and early summer a great many sugar maples suffered from leaf scorch. Some of these trees were so badly injured that they have since died; a great many others have been severely weakened. The writer does not remember ever seeing so much leaf scorch before. Of the twenty-five hundred sugar maples along our highways about one-third of them suffered from leaf scorch. A few Norway maples also were affected.

"During the summer the writer took several trips through different parts of Westchester County and found the conditions the same as in Mount Vernon.

"The leaf scorch was noticed about the first week in June and by the middle of July was very severe." (Adam G. Henn, City Forester, Mount Vernon)

Oregon - a leaf scorch similar to that described in the Plant Disease Bulletin, Supplement 11, p. 292, appeared to some extent on

maples in Portland, during the late spring and summer of 1921. The cause was not determined. (JSB)

Frost injury - a May frost in 1921 caused slight injury to the tender leaves of various maples around Portland, Oregon. Those species leafing out last naturally suffered most. No serious damage resulted. (JSB)

Winter injury
Washington

Chlorosis caused by excess of lime in soil.
Texas - prevalent in limestone soils, reduction in growth about 10%.

OAK, CHESTNUT (Quercus prinus)
Twig blight caused by Physalospora cydoniae Arnaud or Diplodia longispora C. & Ell.

"Twig blight was much less prevalent in Virginia in 1921 than in the two preceding years. It was also noted in 1921 in North Carolina, Tennessee, West Virginia, Maryland, and District of Columbia." (G.F.Gravatt)

OAK, OREGON (Quercus garryana)
Piped rot of the heartwood caused by Polyporus rheades Fr. = (Polyporus dryophilus Berk.)
Oregon (JSB)

Powdery mildew caused by Oidium sp.
Oregon - on coppice sprouts, rare. (JSB)

Mistletoe, Phoradendron villosum Nutt.
Oregon - commonly causes large globose swellings on the trunk and branches of infected trees, widely distributed over range of host. (JSB)

OAK (Quercus spp.)
Anthracnose caused by Gnomonia veneta (Sacc. & Speg.) Kleb. (Gloeosporium nervisequum (Fckl.) Sacc.)
Delaware - general throughout northern part of state, spraying with Bordeaux when leaves were about half grown seemed to reduce injury and infection. (CMS)
Wisconsin - generally prevalent around Milwaukee, slight amount of damage. (CMS)
Iowa - common, trace of loss.

Leaf blister caused by Taphrina coerulescens (D. & M.) Tul.
Pennsylvania - on Quercus coccinea, trees 50-70 feet high were heavily infected, practically all leaves showed many diseased spots. (LOO)
South Carolina - unimportant
Ohio

Powdery mildew caused by Microsphaera alni (Wallr.) Salm.
Georgia - infestation slight and local. (BMC)
Indiana - on Q. pedunculata

Strumella canker caused by Strumella coryneoidea Sacc. & Wint.
Illinois - common on oak in this locality, first observed in 1919.
Oregon - found at one point only, on dead twigs (sporodochial stage), further search for the canker was fruitless and so it is not considered prevalent.

Leaf spot caused by Marssonia sp.
Pennsylvania - State College, Center County, July 17; observed in good fruiting condition on a species of scrub oak on which it was a serious disease during the current year, most of the leaf area was dead. (LOO)

Canker caused by Schizophyllum commune Fr.
Ohio - it is questioned by authorities as to whether Schizophyllum is parasitic, but many times evidence seems to point that way, this occurrence being one of those instances. (CMS)

Bulgaria polymorpha (Oed.) Wett.
Connecticut

Drouth breakdown
Ohio

PEPPER TREE (Schinus molle)
Timber rot caused by Trametes schini Brown
Arizona - southern part of state; of general prevalence and causing severe damage, infection follows after breaking of branches by storms, careless pruning, etc.

Rot caused by Armillaria mellea (Vahl.) Quel.
California - trees so afflicted begin to die from the top downward and when finally dead the roots stink abominably when dug out, so much so that it takes considerable courage and staying power to stay on the job until it is finished. (JA)
According to E. P. Meinecke these trees were killed by Armillaria and the offensive odor was caused by secondary invasion by bacteria.

PERSIMMON (Diospyros virginiana)
Leaf spot caused by Cercospora fuliginosa Ell. & Kell.
Indiana - local and slight. (HET)

PLUM, INDIAN (Osmaronia cerasiformis)
Leaf spot caused by Septogloeum nuttallii Harkn.
Washington (JSB), Oregon (JSB)
Causes premature death of severely infected leaves. Widely distributed in western Washington and Oregon. (JSB)

POPLAR, BLACK (Populus trichocarpa)
Rust caused by Melampsora occidentalis Jackson
Washington (JSB), Oregon (JSB)
Little injury as a rule to infected leaves. (JSB)

Yellow leaf blister caused by Taphrina aurea (Pers.) Fr.
Washington, Oregon (JSB).
This disease is widespread. Infected leaves sometimes badly deformed. (JSB)

POPLAR, LOMBARDY (Populus nigra var. italica)
Yellow leaf blister caused by Taphrina aurea (Pers.) Fr.
Oregon - infected leaves sometimes very misshapen. (JSB)

POPLAR, WHITE (Populus alba)
Rust caused by Melampsora abietis-canadensis (Farl.) Ludw.
Oregon - little injury to infected leaves. (JSB)

POPLAR (Populus spp.)
Canker caused by Cytospora chrysosperma (Pers.) Fr.
Ohio - severe locally, period of greatest injury in midsummer during growing season, favorable weather conditions throughout season; Norway poplar especially susceptible.
Indiana - local prevalence. (HET)
Colorado - (Ann. Rpt. State Entom., Colo., Circ. 28)
Arizona
Utah - poplars in various parts of Utah are being rapidly destroyed by this disease, in many cases whole rows of P. alba bolleana will be destroyed, disease also appears severely on P. nigra and P. carolina; severe on P. tremuloides in the mountains, and in some aspen groves 10 to 25% of the trees will be found dead as a reult of this disease.
Idaho - reported in various parts of the state but not of much importance.
Concerning the distribution of the fungus, (Jour. Agr. Res. 13: 331-345) Long says "Cytospora chrysoperma is rather widely distributed in certain sections of the United States, especially in the southwestern states. It ranges from Texas and Kansas northward to Montana and westward to California. It has been found in nine states: Arizona, Colorado, Kansas, Montana, Nevada, New Mexico, North Dakota, South Dakota, and Texas." Hubert (Phytopath. 10: 442-447. 1920) adds Idaho, Washington, and Wyoming, and Povah (Phytopath. 11: 157-165. 1921) adds New York and lists a new host, P. grandidentata for this pathogen. He also reports that "In the diseased area over 68% of the poplars were infected and over 30% killed."

Hubert, Ernest E. Observations on Cytospora chrysosperma in the Northwest. Phytopath. 10: 442-447. 1920.
Leach, J. G. Poplar canker. Ann. Rept. State Entom., Colorado 11 (Circ. 28): 46 Col. Pl. Agr. 1920.
Long, W. H. An undescribed canker of poplars and willows caused by Cytospora chrysosperma. Jour. Agr. Res. 13: 331-345. Pl. 27-28. 1918.
Povah, A. H. W. Canker disease of poplars in South Africa thought to be identical with Cytospora chrysosperma in America. Jour. Dept. Agr. So. Afr. 2: 310. Apr. 1921.
__________ An attack of poplar canker following fire injury. Phytopath. 11: 157-165. Fig. 1-3. April 1921.

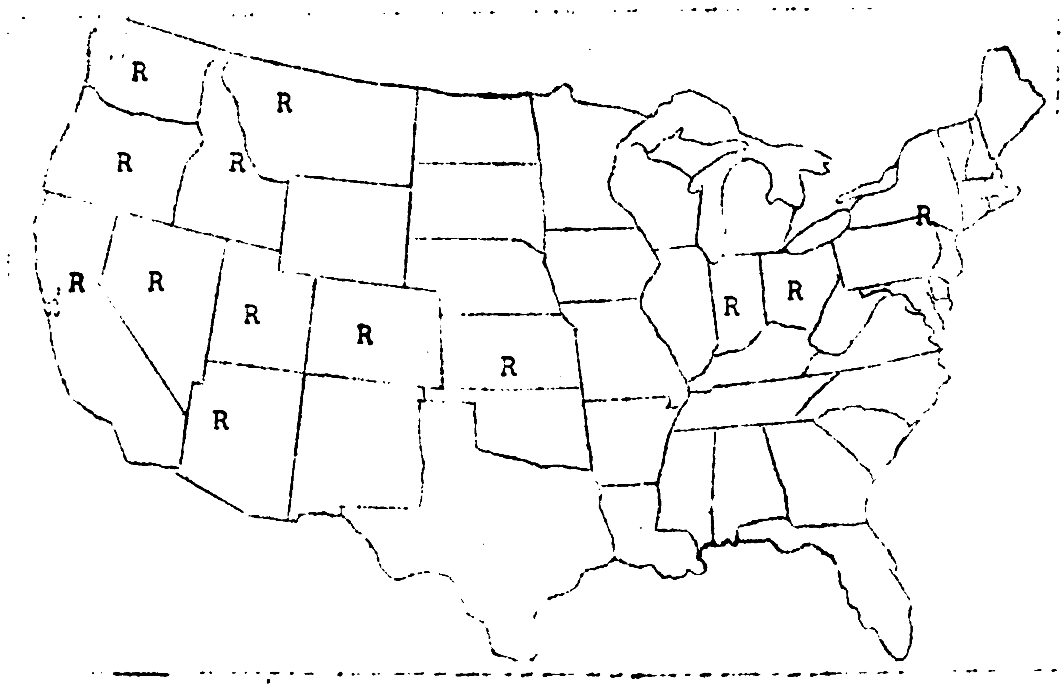

Fig. 94. Geographical distribution of poplar canker caused by Cytospora chrysosperma (Pers.) Fr. in the U. S., as reported to the Plant Disease Survey.

European canker caused by Dothichiza populea Sacc.
Connecticut - more prevalent than in previous years.
Minnesota - weather relations were dry and hot; disease common.
Illinois (RBM)

Anthracnose caused by Marssonia populi (Lib.) Sacc.
New York
New Jersey - abundant.

Anthracnose caused by Marssonia sp.
Washington - moderately severe.

Rust caused by Melampsora medusae Thüm.
South Carolina - unimportant.
Iowa - very common.

Rust caused by Melampsora magnusiana G. Wagner
Colorado

Rust caused by Melampsora sp.
Washington

Scab caused by Venturia tremulae Aderh. = (Fusicladium tremulae Fr.)
Washington

Canker caused by Hypoxylon pruinatum (Klotsch) Cke.
Has been found in New York and Michigan on Populus tremuloides according to Povah, Alfred H. W. Hypoxylon poplar canker. (Abstract) Phytopath. 12: 59. Jan. 1922)

Leaf spot caused by Sclerotium bifrons Ell. & Ev.
Colorado.

Powdery mildew caused by Uncinula salicis (DC.) Wint.
Ohio (BF)

White butt rot caused by Fomes applanatus (Pers.) Wallr.
Connecticut - on roots of a living tree in a yard following injury by crown gall.

White heartwood rot caused by Fomes igniarius (L.) Fr.
Idaho - found generally on Aspen throughout range of host in state.

Heart rot caused by Pleurotus ostreatus (Jacq.) Fr.
Idaho - damage is caused by breaking of trees easily due to wind, after the fungus has attacked the trees.

Canker, cause undetermined.
Wisconsin - bad on Lombardy poplar in northwest section of the state.

SERVICE BERRY, WESTERN (Amelanchier alnifolia)
Leaf spot caused by Dimerosporium collinsii (Schw.) Thüm.
Oregon - common in southern part of state, the infected leaves are killed. This fungus also causes the formation of witches brooms on the host. (JSB)

Powdery mildew caused by Phyllactinia corylea (Pers.) Karst.
Oregon - causes slight injury. (JSB)

Rust caused by Gymnosporangium blasdaleanum (D. & H.) Kern
Oregon - cluster cups were most abundant on the fruits and stems, causing hypertrophy and were found sparingly on the leaves. (JSB)

Rust caused by Gymnosporangium harknessianum (Ell. & Ev.) Kern
Oregon - this rust caused hypertrophy of the stems and fruit of the host, probably common in southern part of state. (JSB)

SERVICE BERRY (Amelanchier cusickii)
Leaf and fruit blight caused by Sclerotinia gregaria Dana
Washington

SYCAMORE (Platanus occidentalis)
Anthracnose caused by Gnomonia veneta (Sacc. & Speg.) Klebahn = (Gloeosporium nervisequum (Fckl.) Sacc.
Connecticut - more prevalent than in previous years.
New Jersey
Maryland - trees near Baltimore badly affected. (FWB)
Ohio - severe, causing defoliation and death of shoots, period of greatest injury during June and July.
Iowa - much less than any in the past five years.
Indiana - worse than in previous years, bad on ornamental sycamores.

Utah - The American varieties of sycamore throughout the state were entirely defoliated during the spring. With the advent of dry weather, however, the trees recovered and nothing but the dead and cankered twigs at present show the effects. The European varieties appeared to be highly resistant showing very little trouble even when surrounded by diseased individuals of the American type.

Powdery mildew caused by Microsphaera alni (Wallr.) Salm.
Delaware - serious injury to young growth.

Winter injury
Ohio

Blight or leaf curl, caused undetermined
Pennsylvania - the native Plane tree (Platanus occidentalis) throughout the rural district surrounding Philadelphia is afflicted with a blight or leaf curl similar to that of the American Beech. The leaves burn at the edges, curl up and die. Not all of the trees are so affected, but large specimens here and there are very conspicuous as one motors along the country roads. Possibly the frost of March 29 had something to do with it. (AM)

TULIP TREE (Liriodendron tulipifera)
Anthracnose caused by Colletotrichum sp.
Pennsylvania - occupying a few dead areas on leaves bearing also Discosia artocreas (Tode) Fr. (LOO)

Leaf spot caused by Discosia artocreas (Tode) Fr.
Pennsylvania - occupying definite dead spots, circular in outline. (LOO)

UMBRELLA TREE (Melia sp.)
Texas root rot caused by Ozonium omnivorum Shear
Texas - prevalent, 2% loss.
Arizona

WALNUT (Juglans spp.)
Leaf spot caused by Gnomonia leptostyla (Fr.) Cv. & De Not. = (Marssonia juglandis (Lib.) Sacc.)
New York - limbs dying and the leaves on the tree noticed were badly spotted.
Illinois
Iowa - rare

Powdery mildew caused by Phyllactinia corylea (Pers.) Karst.
Ohio - on Juglans nigra (BF)

Crown gall caused presumably by Bacterium tumefaciens EFS & Town.
Arizona - on Juglans rupestris in southern part of state, May, local, causing a moderate amount of damage.

Frost injury
Maryland - on Juglans cordiformis, branches were killed.

WILLOW (Salix spp.)
Rust caused by Melampsora bigelowii Thüm.
Pennsylvania (LOO)
Minnesota - not important.
Washington (JSB)
Oregon - widespread throughout range of host, causing premature yellowing of infected leaves which may drop from the tree. (JSB)

Rust caused by Melampsora confluens (Pers.) Cast.
Oregon - occasional occurrence throughout range of the host, little injury to the leaves. (JSB)

Rust caused by Melampsora sp.
Pennsylvania - appeared more abundantly than in 1920 on stems of basket willow. (LOO)
Iowa - common
Idaho - common in northern part of state.
Washington

Powdery mildew caused by Uncinula salicis (DC.) Wint.
Washington - common, trace of injury.
Oregon - causes little injury to host. (JSB)

Rot caused by Fomes applanatus (Pers.) Wallr.
Oregon (JSB)
This fungus is a wound parasite on living trees. Occurrence rare. (JSB)

White heartwood rot caused by Fomes igniarius (L.) Gill.
Oregon (JSB)

Tar spot caused by Rhytisma salicinum Fr.
Washington, Oregon.
Probably widespread throughout range of host in western Washington and Oregon, causes little injury to host. (JSB)

Crown gall caused by Bacterium tumefaciens EFS. & Town.
Connecticut - slight injury, a new host to state.
Texas - trace, mostly aerial galls.

Leaf blight caused by Cylindrosporium sp.
Washington

Twig spot caused by Marssonia sp.
Washington

WITCH HAZEL (Hamamelis virginica)
Leaf spot caused by Phyllosticta hamamelidis Cke.
Pennsylvania - When found on June 9 some spots were 3 cm. in diameter, involving considerable leaf area. Later in the season the spots may be even larger and the characteristic dark red brown areas

resemble injury by sunscald. Observations on the above data show as conclusively as can be shown with controlled inoculations that this fungus is primarily responsible. Small dead areas circumscribed by a very narrow dark line are the earlier evidence of infection. Spots 6 mm. in diameter are found producing pycnidia. Later in the season a coremium forming imperfect fungus also appears but is undoubtedly entirely saprophytic. There is a distinct tendency for the pycnidia to be formed in lines along the veins of the leaf. (LCO)

DISEASES OF ORNAMENTAL PLANTS

AMPELOPSIS SPP.

Leaf spot caused by Guignardia bidwellii (E.) V. & R. = (Phyllosticta ampelopsidis)
Illinois - common on host everywhere, worse than in 1920.
Indiana

Downy mildew caused by Plasmopora viticola (B. & C.) Berl. and De Ton.
Pennsylvania - on A. quinquefolia

Powdery mildew caused by Uncinula necator (Schw.) E. & E. = (U. ampelopsidis Pk.)
Delaware - on A. quinquefolia

Canker caused by Neotria cinnabarina Fr.
Idaho - very slight, found on vines which seemed to have suffered winter injury.

Leaf spot caused by Septoria hederae West.
Indiana - local and slight. (HET)

ANEMONE (Anemone sp.)

Leaf spot caused by Alternaria sp.
Ohio - first report of this disease from this state, negligible in importance.

ASTER, CHINA (Callistephus chinensis)

Wilt caused by Fusarium conglutinans callestephi Beach
New York - severe, in Genesee County 25,000 plants were affected.
Virginia - caused very severe damage in a greenhouse at Richmond.
Ohio - general distribution serious and of much greater prevalence than in 1920, 25% loss the maximum in any one field, earliest reported appearance 1921 was in June, the peak of greatest injury occurred in late June and early July at the time of transplanting, both moisture and temperature conditions were favorable to the disease.
Indiana - has become a limiting factor in aster growing within the state, bad in greenhouses and garden plots.
Illinois - probably distributed over entire state, disease very pronounced in 1921, greater amount than average year, very important locally

from 50 to 75% of plantings in the state infested, 10% of plants infested caused a reduction of about 10%, attacks worst in July and August at the time of flowering and before, low moisture and high temperature prevailed during growing season, practically all varieties were attacked, no remedies known.

Michigan - common everywhere,- depending on nature of planting stock.

North Dakota - less prevalent than in 1920.

Idaho

Oregon - first report

Yellows, cause unknown

New York

Pennsylvania - severe locally.

Illinois - probably found throughout state, a more pronounced prevalence in 1921, period of greatest injury July and August before flowering; all varieties seem susceptible; weather relations during year consisted of a low moisture and a high temperature. (PAL)

Rust caused by Coleosporium solidaginis (Schw.) Thüm.

New York

Pennsylvania

Leaf spot caused by Septoria callistephi Gloyer

Illinois - serious on young plants growing in the University greenhouse. First report in Illinois.

This is the first definite report to the Plant Disease Survey of the occurrence of this disease from states west of New York. In 1920 Michigan reported a leaf trouble caused by Septoria sp.

BACHELORS BUTTON (Centaurea sp.)

Rhizoctonia rot caused by Rhizoctonia sp.

Indiana - local, infection slight, caused a rotting of the stems.

BARBERRY (Berberis spp.)

Rust caused by Puccinia fendleri (T. & E.) Jackson

Washington - on Berberis aquifolium

Rust caused by Puccinia mirabilissima Pk.

Washington - on Berberis aquifolium

Rust caused by Puccinia graminis Pers.

(See wheat stem rust, Pl. Dis. Bul. Suppl. 21: 166-176. 1922)

Angular leaf spot caused by Bacteria sp.

Illinois - in northern portion of state, causes spotting of leaves.

Idaho

BEGONIA (Begonia sp.)

Leaf blight caused by Botrytis sp.

Indiana - general and slight, appears to be spread in greenhouses by mites and ants. (HET)

CALENDULA OFFICINALIS

Rust caused by Puccinia recedens Syd.
Illinois, Nebraska
Has not been previously reported in the United States.

CANNA (Canna sp.)

Rust caused by Puccinia cannae (Wint.) P. Henn.
Florida (JAS)
Canal Zone - Panama City, March 17; collected by A. Zetek and I. Molino.

Mosaic cause unknown
Hawaii - frequently observed on C. indica (OLK)

Bacterial bud rot
Nebraska - important locally, considerable damage around Lincoln shown by the numerous reports received.

CARNATION (Dianthus caryophyllus)

Rust caused by Uromyces caryophyllus (Schw.) Wint.
New Jersey - common but not serious.
Ohio - appears chiefly as a greenhouse disease but occurs infrequently also as a disease of garden carnations, attacks the host in its vegetative period, injuring the plant by distorting and killing the leaves.
Indiana - noted in greenhouse, not important during year.
Colorado - unimportant.

Root and stem rot caused by Rhizoctonia sp.
New Jersey - common but not serious
Pennsylvania - undoubtedly general, but little data is available, only report from College greenhouse.
Illinois - found over entire state, more prevalent from center of state, south. Earliest appearance in June. Does greatest amount of damage in August and September, attacks host at first flowering period. All varieties are susceptible, no treatment known.
Washington

Root knot caused by Heterodera radicicola (Greef.) Müller
Texas - unimportant
Washington

Bud rot caused by Sporotrichum poae Ph.
Pennsylvania - in State College greenhouses.
Indiana - loss was slight on some varieties, one grower was forced to stop growing Matchless variety due to its susceptibility to bud rot. (HET)

Leaf mold caused by Heterosporium echinulatum (Berk.) Cke
Oregon - caused a $500 loss in a greenhouse where 75% of the plants were reported attacked. Nature of injury was in way of leaf spot, stunting and killing of plants. The dark prolonged winter weather which reduced photosynthesis and promoted dampness

assisted considerably in producing the large amount of the disease. Varietal susceptibility was noticeable as the Matchless was most severely attacked and proved nearly worthless while the Aviator was not bothered so much and the crop not reduced. The Enchantress Supreme was the least susceptible.

CHRYSANTHEMUM (Chrysanthemum hortorum)

Leaf spot caused by Septoria chrysanthemi Cav.
Texas - trace, unimportant.

Sooty mold caused by Fumago sp.
Texas - trace, unimportant.

Leaf spot caused by Phyllosticta chrysanthemi E. & D.
Virginia - caused severe damage in a greenhouse.

Powdery mildew caused by Erysiphe cichoracearum DC. = (Oidium chrysanthemi)
Ohio

Rust caused by Puccinia chrysanthemi Roze.
Ohio

DAFFODIL (Narcissus pseudo-narcissus)

Nematode caused by Tylenchus dipsaci (Kühn) Bastian)
Illinois - found in a bulb garden, attacking the leaves.

DAHLIA (Dahlia sp.)

Powdery mildew caused by Erysiphe cichoracearum DC.
Ohio

Drought injury
Connecticut - considerable injury in midsummer apparently due to drought.

EVONYMUS (Evonymus sp.)

Powdery mildew caused by Microsphaera alni (Wallr.) Salm.
Ohio

Leaf spot caused by Exosporium concentricum Heald & Wolf.
Texas - very prevalent.

Anthracnose caused by Colletotrichum griseum Heald & Wolf
Texas - prevalent.

DIANELLA ODORATA

Mosaic, cause undetermined
Hawaii - a disease closely resembling the yellow stripe disease of sugar cane. (LOK)

DIANTHUS PLUMARIUS

Southern blight caused by Sclerotium rolfsii Sacc.
South Carolina - not important.

FREESIA (Freesia sp.)

Nematode, Heterodera radicicola (Greef) Müller

California - a considerable number of plants yellowing were found in many fields near Santa Cruz. The plants were growing on sandy soil which was well drained. (WSF)

GERANIUM (Pelargonium sp.)

Gray mold caused by Botrytis sp. producing leaf spot and blossom blight.

Ohio

Kansas - was quite serious.

Dropsy, cause physiological

Ohio - general throughout state, importance slight in 1921, nature of injury is an excess number of blisters on the leaves, a physiological condition which is caused by excessive moisture, more frequent in greenhouses, seldom seen out doors.

Rhizoctonia rot caused by Rhizoctonia sp.

Indiana - local and moderately severe.(HET)

GLADIOLUS (Gladiolus sp.)

Fusarium rot probably caused by Fusarium oxysporum Schlecht. var.

Massey, L. M. Fusarium rot of gladiolus (Abstract) Phytopath. 12: 53. Jan. 1922.

GOLDEN GLOW (Rudbeckia laciniata)

Powdery mildew caused by Erysiphe cichoracearum DC.

Connecticut

HEPATICA (Hepatica sp.)

Smut caused by Urocystis anemones (Pers.) Wint.

Ohio - leaves were attacked.

HIBISCUS SABDARIFFA L.

Foot rot caused by Phytophthora terrestria Sherb.

Porto Rico (JM)

HIPPEASTRUM SP.

Mosaic, cause undetermined

Hawaii - frequently observed. (LOK)

HOLLYHOCK (Althea rosea)

Rust caused by Puccinia malvacearum Mont.

Connecticut - average amount.

New York - found in state wherever hollyhocks are grown.

Virginia - general throughout state.

Ohio - general over state April 24, greatest damage is done in midsummer

by impairing the vigor of the leaves.
Colorado
Washington - general throughout state.
Oregon - general throughout western part of state, worst disease of the hollyhock.
California - not as abundant as in 1920. (WSF)

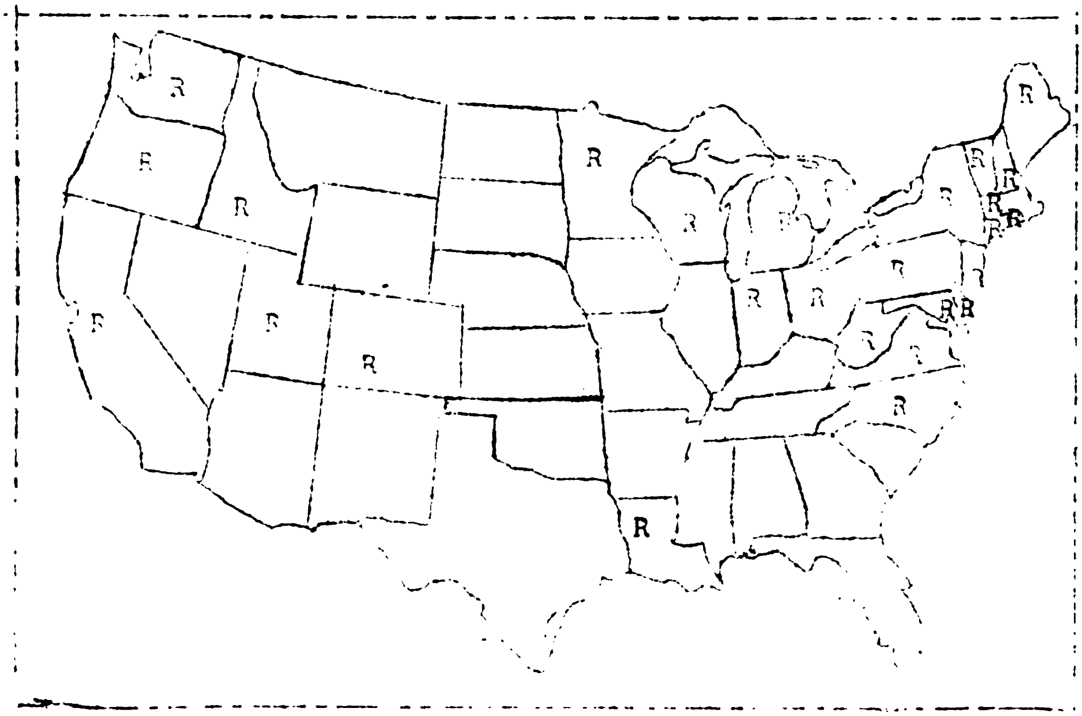

Fig. 95. Geographical distribution of Puccinia malvacearum on Althea rosea in the U. S., as reported to the Plant Disease Survey.

Leaf spot caused by Cercospora althaeina Sacc.
Delaware, Minnesota.

Anthracnose caused by Colletotrichum malvarum (B. & C.) South.
Delaware - stem and leaf infection.

Root rot caused by Ozonium omnivorum Shear
Texas - important, reduces the crop about 10%.

HYDRANGEA (Hydrangea hortensia)
Leaf spot caused by Phyllosticta hydrangeae Ell. & Ev.
New York

Frost injury
Ohio

IRIS (Iris spp.)
Sclerotium caused by Sclerotium rolfsii Sacc.
California - to all appearances was secondary following insect injury. (WSF)

Rhizome rot caused by bacteria
Indiana - local, on imported rhizomes in a garden.

JASMINE, CAPE (Gardenia jasminoides)
Leaf spot caused by Macrosporium sp.
Ohio.

LARKSPUR (Delphinium sp.)
Blight caused by Bacterium delphinii EFS
Connecticut

Wilt caused by Fusarium sp.
Ohio - this is the first report of this disease in the state, probably a soil infection as a considerable amount of Fusarium was found in the soil.
Wm. Small published in the Bull. Mis. Inform. Kew, on page 321-328, 1920, on a wilt of the carnation in England.

Rhizoctonia stem rot caused by Rhizoctonia sp.
Indiana (HET)

LILAC (Syringa spp.)
Powdery mildew caused by Microsphaera alni (Wallr.) Salm.
Connecticut
Ohio - average amount as in previous years.
Illinois - generally distributed throughout state, worse than preceding year or years, about 70% of the plants in the state were affected, caused a withering of the leaves.
Iowa - more prevalent, affected practically all the plants in the state, actual loss slight.

Dodder (Cuscuta sp.)
Missouri

Winter injury
Washington

LILY, EASTER (Lilium candidum)
Leaf spot caused by Sclerotinia libertiana Fckl.
Connecticut - a new trouble, rather bad at Madison, New Haven County.

MATRIMONY VINE (Lycium sp.)
Powdery mildew caused by Microsphaera sp.
Ohio

MORNING GLORY (Ipomoea purpurea)
White rust caused by Albugo sp.
Missouri - very common locally.

NASTURTIUM (Tropaeolum sp.)
Dodder caused by Cuscuta sp.
Missouri

OLEANDER (Nerium oleander)
Gall caused by Bacterium savastanoi var.
Arizona - southern part of state, disease affects stems, leaves and even flower clusters, appears to be increasing.

OLEASTER (Elaeagnus angustifolia)
Root galls caused by Mycodomatia
Washington

PANSY (Viola tricolor)
Rust caused by Puccinia violae (Schum.) DC.
South Carolina - not important.

Rust cause undetermined
Connecticut - aecia were found on plants purchased from a dealer. (JLS)

Anthracnose caused by Colletotrichum violae tricoloris R. G. Sm.
New York

Root rot caused by Rhizoctonia sp.
Delaware - severe injury to plants in cold frame, same soil had been used for ten years.

Chlorosis caused by lime
Washington

PEONY (Paeonia officinalis)
Bud rot and leaf spot caused by Botrytis sp.
Pennsylvania
Ohio - rather severe, of general distribution over the state.
Indiana - general over state, caused some damage. (HET)
Washington

Leaf blotch caused by Cladosporium paeoniae Pass.
Pennsylvania - apparently a new disease, general over state.
Indiana - caused a great deal of damage at Bridgeport where plants had not been cut back, moderately severe. (HET)

Fusarium leaf and stem blight caused by Fusarium sp.
Indiana - produced a slight amount of damage, caused a blackening of the stem and leaves. (HET)

Root rot caused by Armillaria mellea (Vahl.) Quel.
Michigan - found in a bed where forest litter had been used.

Crown gall caused by Bacterium tumefaciens EFS & Town.
Michigan

PETUNIA (Petunia sp.)
Mosaic, cause undetermined
Pennsylvania (FW), Iowa

Rhizoctonia caused by Rhizoctonia sp.
Pennsylvania (FW)

PHLOX (Phlox sp.)
Powdery mildew caused by Erysiphe cichoracearum DC.
Connecticut - average prevalence.
New York - moderately severe
Maryland - local heavy infestation (GHM)
Ohio
Indiana - moderately severe. (HET)
Washington

Leaf spot caused by Cercospora sp.
New York

PRIMROSE (Primula sp.)
Root knot caused by Heterodera radicicola (Greef) Müller
Connecticut - bad on roots of host in greenhouse at station, but does not seem to hurt them much.

PRIVET (Ligustrum vulgare)
Powdery mildew caused by Microsphaera alni (Wallr.) Salm.
Indiana - worse than in previous years, causes objectional appearance to hedges.
Illinois - general throughout state, worse than in previous years, very serious on hedge plants, not found on Regal privet.

Root rot caused by Ozonium omnivorum Shear
Texas - prevalent, reduction in yield about 2%.

Anthracnose caused by Glomerella cingulata (Atk.) S. & S. = (Gloeosporium cingulatum Atk.)
Ohio
Texas - prevalent, about 1% reduction.

Leaf spot caused by Exosporium concentricum Heald & Wolf
Texas

Frost injury
Texas - unimportant

Winter and drought injury
Ohio

RHODODENDRON (Rhododendron californicum)
Leaf spot caused by Cryptostictis sp.
Oregon (JSB)

Rust caused by Melampsoropsis piperiana Arth.
Oregon (JSB)

Bud rot caused by Sporocybe azaleae (Pk.) Sacc.
Oregon (JSB)

Witches broom, cause unknown
Oregon - appearance of the broom suggests an Exobasidium not uncommon. (JSB)

ROSE (Rosa spp.)

Powdery mildew caused by Sphaerotheca spp.

Reported from New Hampshire, Connecticut, New York, Delaware, North Carolina, South Carolina, Texas, Arkansas, Ohio, Indiana, Kansas, Arizona, Idaho, Washington, Oregon, and California.

This disease was more prevalent and serious than in 1920 in all of the states reporting its occurrence with the exception of Idaho. In Oregon it is the worst rose trouble; in Texas it was epidemic. Leaves, twigs and young shoots were affected. Kansas reports that it is more or less prevalent each year regardless of the climatic conditions. That the ramblers are the worst and most commonly affected is shown by reference to their susceptibility from Connecticut, Delaware, Arkansas, Indiana, Oregon, and California. In California the following varieties were also susceptible Madam Abel Chatenay, Madam Cochet,Ulrich Brunner, Pink Rambler, Marie Henrietta, Bride, Bridesmaid, Radiance. The Killarney and Bride varieties were affected most in Indiana. Sulphur spray was suggested as a means of treatment from Oregon.

Dates of first appearance:

May 20, Indiana	June 1, Kansas	June 8, Delaware
May 25, Ohio	June 1, California	June 24, New Hampshire
June. New York	June 7, Oregon	August 19, Arizona
	June 8, Connecticut	

Bruce Fink in his notes on powdery mildews of Ohio (Ohio Journ. Sci. 21: 211-216, April 1921) says that this species seems to be the one which causes the injury to the roses generally in Ohio and throughout other parts of the United States, also that Salmon says that S. pannosa (Wallr.) Lev. which is the common powdery mildew of the rose in Europe is according to his opinion replaced by other species of Sphaerotheca in America. This is one of the diseases that might warrant further study in the United States.

The following map shows the distribution of the species of Sphaerotheca which have been reported at various times to the Plant Disease Survey.

Leaf blotch caused by Actinonema rosae (Lib.) Fr. = (Diplocarpon rosae Wolf)

Connecticut, Delaware, Texas, Ohio, Indiana, Michigan, Arkansas (all over state), Missouri, Washington, Oregon (western portion of state), and California.

It is of interest to note that its occurrence in the Pacific Coast States is most always in the more humid districts. In Washington the greatest prevalence was around the Puget Sound Region, in Oregon it occurred in considerable amount in the coast counties, and in California the same was true especially around the San Francisco Bay Region. In Delaware, Texas, Washington, Oregon, and California it was very prevalent, and epidemic in Texas. Varietal differences

Varietal differences were noted, being very common on the Jack Rose in Indiana, in Oregon varietal differences in susceptibility were strongly apparent. Found both on field and greenhouse plants in

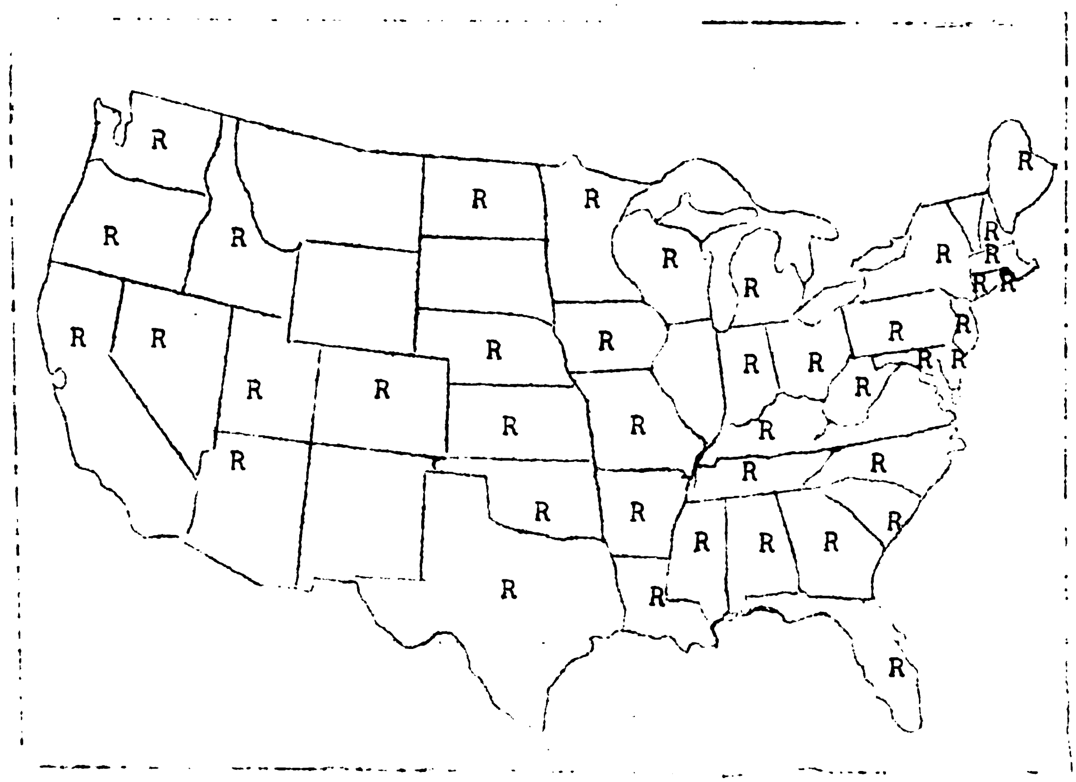

Fig. 96. Geographical distribution of Powdery Mildew of the rose caused by Sphaerotheca spp. in the U. S. as reported to the Plant Disease Survey.

Indiana. Gardner, of Indiana, reports that C. L. Burkholder held the disease in check with Bordeaux mixture 2-4-50 (Pyrox) until August 1, at which time spraying was discontinued. In Michigan "Grape Dust" a sulphur-tobacco mixture was used, but without effect.

Dates of earliest appearance:

May 17, Oregon	June 28, Connecticut
June 27, Ohio	August 20, Delaware.

Rust caused by Phragmidium rosae-californicae Diet.
Washington, Oregon. (JSB)

Rust caused by Phragmidium spp.
Illinois - somewhat general in distribution in state.
Washington - common throughout state.
Oregon - western counties.
California - throughout state
Varietal susceptibility was noticed in Indiana where the disease was serious on wild rose (Rosa setigera) which is commonly grown in lawns throughout state. In California it was severe on certain varieties (MMadam Abel Chatenay, American Beauty, Paul Neyron, General McArthur, Killarney, Marie Henrietta, and Sainsborough Pink. In Oregon no varietal susceptibility was noticed, does not appear to be increasing greatly there.

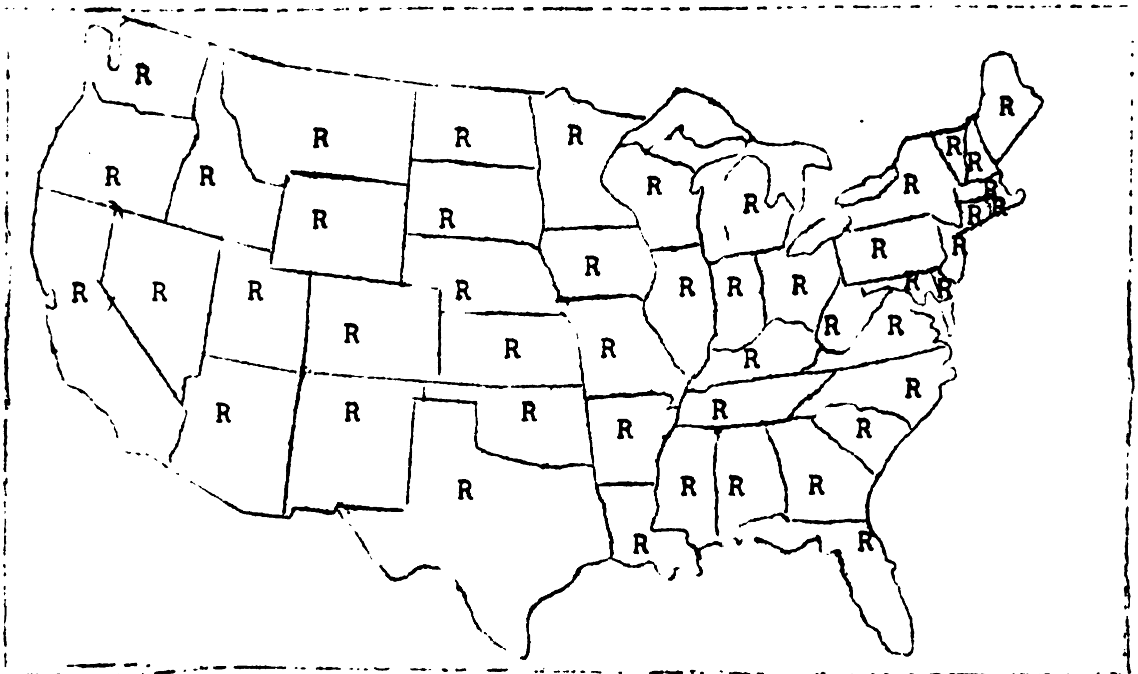

Fig. 97. Geographical distribution of leaf blotch of rose in U. S. as reported to the Plant Disease Survey.

Dates of earliest appearance of Phragmidium spp. of the rose:
May 27, Illinois   June 2, Oregon   August 11, California.

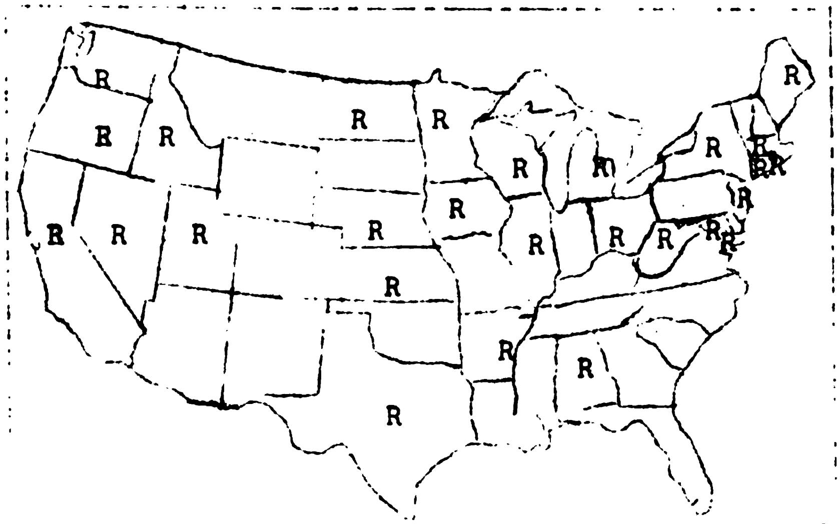

Fig. 98. Geographical distribution of rose rust in the U. S. as reported to the Plant Disease Survey.

Crown gall caused by Bacterium tumefaciens EFS & Town.

Indiana - general prevalence, causing severe damage and about 75% reduction in yield, affects the Ophelia rose and is apparently being distributed on the roots of diseased stock by the nurseries. (HET)

An important disease especially in the nurseries. (Tahon)

Texas root rot caused by Ozonium omnivorum Shear

Texas - general in central eastern section of state, prevalent, about 2% reduction in plants found in the state in the black lands.

Canker or cane blight caused by Leptosphaeria coniothyrium (Fckl.) Sacc. = (Coniothyrium sp.)
North Carolina - very common, important.
Texas - trace only.
Indiana - general and doing a moderate amount of damage. (HET)
An interesting note by H. T. Güssow in the Bull. Soc. Path. Veg. France 8: 30. Jan.-Mar. 1921, states that he now considers that rose canker is caused by Bacterium tumefaciens and not by Coniothyrium sp.

Canker caused by Diaporthe umbrina Jenk.
Delaware (Newark, New Castle County, April) - not previously reported; Prof. Houghton has observed this disease the past two years on Jack Rose and Rosa sp.
This is the first report to the Plant Disease Survey from any state.

Canker caused by Cylindrocladium scoparium Morg.
Pennsylvania - very severe cases found in vicinity of Philadelphia in several whosesale rose establishments. In one place 10,000 Russel plants were lost, in another 3,000 Premier plants died, and in a third place 1,200 Killarney and Columbia plants had to be replaced. (CAW)
First report to Plant Disease Survey from Pennsylvania.

Canker, cause undetermined.
Idaho

Botrytis rot caused by Botrytis sp.
Texas,-trace, unimportant.

Anthracnose caused by Gloeosporium rosae Hals.
Texas - trace.
Ohio - period of greatest injury was during June and July upon the vegetative part of the host in affecting the stem, more prevalent than past year but of moderate amount, weather was favorable for disease.

Chlorosis caused by excess of lime in the soil.
Texas - prevalent in limestone soil.

Winter injury
Washington

Fertilizer injury caused by too much fertilizer.
Indiana - caused a yellowing and dropping of leaves. (HET)

SEDUM SPECTABILIS
Leaf spot caused by Septoria sedi West.
Illinois - serious on this ornamental Sedum in the late fall.

SNAPDRAGON (Antirrhinum spp.)
Anthracnose caused by Colletotrichum sp.
Indiana (HET)

Rust caused by Puccinia antirrhini Diet. & Holw.

This disease was reported to the Plant Disease Survey for the first time from South Carolina, Kansas, North Dakota, and Arizona. Previously reports have been received from Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, South Carolina, Ohio, Indiana, Michigan, Iowa, Missouri, North Dakota, Nebraska, Kansas, Utah, Arizona, Washington, Oregon, and California. Snapdragon rust was severe in South Carolina (locally), North Dakota, Kansas, Arizona, and Oregon. In Oregon it was given as the worst disease they had. The dates of first appearance are scattered throughout the year as some of the reports were of greenhouse infestations.

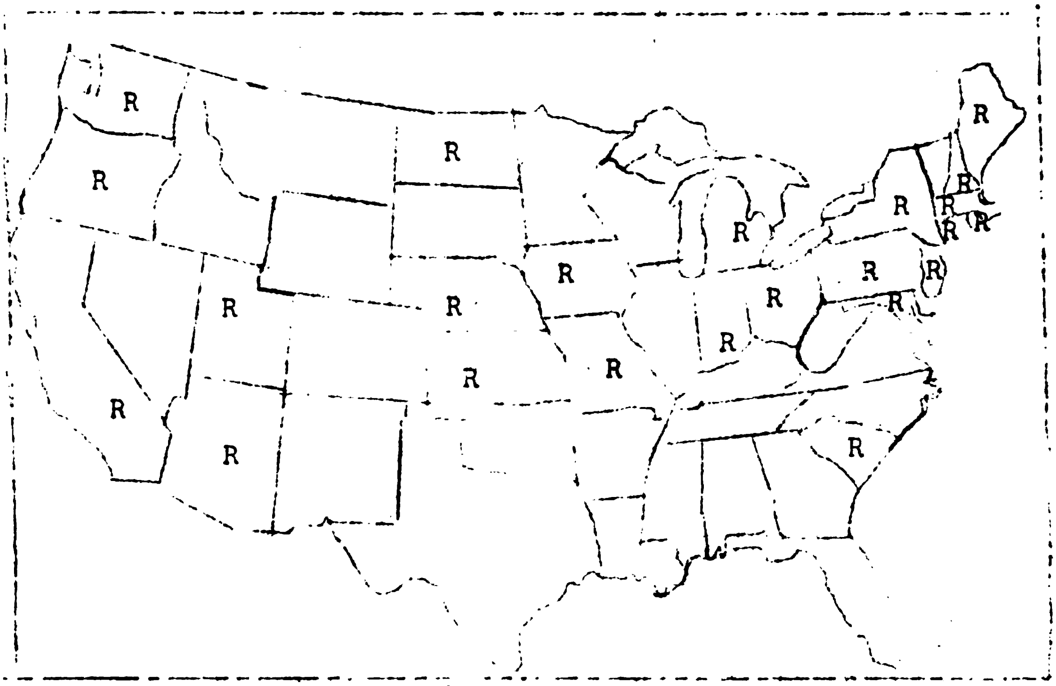

Fig. 99. Geographical distribution of snapdragon rust in the U. S. as reported to the Plant Disease Survey.

The following extract may be of assistance to those who grow snapdragons both commercially and privately.

"During 1919 the effect of temperature on the germination of snapdragon spores was studied as well as the effect of temperature on the duration of the incubation period. In field experiments on the control of the disease the following fungicides were used: cuprammonium sulphate, cupric acetate, sulphur, and sulphur containing 12% bisulphite of soda. The weather during the greater part of the growing season was cold, and the copper fungicides afforded the best protection. In 1920 field experiments were made on the control of snapdragon rust by means of calcium polysulphide, sulphur, and sulphur plus varying percentages of soot. The results obtained indicate that sulphur affords better protection than calcium polysulphide, but that contrary to the opinion generally current, the addition of soot to sulphur did not

increase its efficiency." (Butler, O. R. Rept. of the New Hampshire Agr. Exp. Sta. for biennium ending June 30, 1920. New Hampshire Agr. Exp. Sta. Bul. 198. May 1921)

A bacterial leaf spot caused by Pseudomonas antirrhini Takimoto, has been reported from Japan, (Takimoto, Seito. Bacterial leaf-spot of Antirrhinum majus L. Bot. Mag. Tokyo 34: 253-257. Oct. 1920.) but this office has no record of its ever having been collected in the United States.

Septoria leaf spot caused by Septoria antirrhini Desm. has recently been referred to from France. (Ducomet, Vital. Sur le Septoria antirrhini Desm. Bull. Soc. Path. Veg. 8: 33. Jan.-Mar. 1921.) This disease has not yet been reported to the Plant Disease Survey as being found in the United States.

SNOWBERRY (Symphoricarpus spp.)

Rust caused by Puccinia symphoricarpi Hark.
Washington, Oregon (JSB)
California - on S. racemosus.
An aecial stage was found on same host in exactly same locality in the spring. (WSF)

Powdery mildew caused by Microsphaera diffusa Cke. & Pk.
Ohio - on Symphoricarpus vulgaris (BF)
Washington - on Symphoricarpus sp.

Leaf spot caused by Septoria symphoricarpi Ell. & Ev.
Washington

SPIRAEA (Spiraea douglasii)

Cylindrosporium sp.
Oregon (JSB)

SWEET PEA (Lathyrus odoratus)

Powdery mildew caused by Sphaerotheca pannosa (Wallr.) Lév.
Washington

Powdery mildew caused by Erysiphe polygoni DC.
Indiana - destructive in the greenhouses by killing the old leaves, worse than in previous years.

Powdery mildew, cause undetermined
Ohio - first report.

Root rot and wilt caused by Fusarium sp.
New York - root rot appearing June 29, and the wilt on July 26.
North Dakota.

Black root rot caused by Thielavia basicola (B. & Br.) Zopf.
Connecticut - Found October 7 on greenhouse stock.

Damping off caused by Pythium debaryanum Hesse
Connecticut - June 10, local.

Mosaic cause undetermined
Washington
California - quite general in southern California. (DGM)

Rhizoctonia caused by Rhizoctonia sp.
Washington

SYRINGA (Philadelphus sp.)
Rust caused by Gymnosporangium gracilens Kern & Bethel
"About six years ago I sent Dr. Jaczewski culture of the telia of Gymnosporangium gracilens Kern & Bethel, and he succeeded in growing it on Philadelphus. This result is noteworthy in two respects: first, it is an unusually long period for a gelatinous rust to retain its viability, being three weeks in transit. Second, it establishes the fact that this rust is the same as that found on Philadelphus in Asia Minor. Hitherto, it was supposed to be an endemic of the desert regions of the southwestern United States." (EB)

TULIP
Mold caused by Sclerotinia parasitica Massee = (Botrytis tulipae (Libert) Hopkins
Washington.

VACCINIUM SPP.
Stem blister caused by Calyptospora columnaris (Alb. & Schw.) Kühn.
Washington, Oregon. (JSB)

Leaf spot caused by Exobasidium vaccinii (Fckl.) Wor.
Washington (JSB)

Rust caused by Pucciniastrum myrtilli (Schum.) Arth.
Oregon (JSB)

VIOLET (Viola spp.)
Black root rot caused by Thielavia basicola (B. & Br.) Zopf.
Connecticut - reported by a greenhouse grower as troublesome.

Root rot caused by Pythium debaryanum Hesse.
Connecticut - reported from a greenhouse.

Southern blight caused by Sclerotium rolfsii Sacc.
South Carolina

DISEASES OF MISCELLANEOUS PLANTS

Althaea ficifolia Cav. — Antwerp hollyhock
  Puccinia malvacearum Bertero — Rust
    Oregon (JSB)

Amaranthus graecizans — Tumbleweed
  Albugo candida (Pers.) Kuntz. — White rust
    Maryland (Detmold, Allegany County) - Sept. 16 (GHM)

Artemisia tridentata Nutt. — Sagebrush
  Puccinia absinthii (Hedw. f.) DC. — Rust
    Washington
    Oregon - probably widespread throughout district, does little injury to host. (JSB)

Asclepias syriaca L. — Milkweed
  Mosaic — Mosaic
    Wisconsin

Ceanothus velutinus Dougl. — Buckbrush
  Cylindrosporium ceanothi Ell. & Ev. — Leaf spot
    Oregon (JSB)

Cerastium sp. — Mouse-ear chickweed
  Rhizoctonia solani Kühn. — Brown patch
    General - throughout eastern United States (Piper)

Circaea pacifica Asch. & Magn. — Enchanters nightshade
  Puccinia circaeae Pers. — Rust
    Washington (JSB)

Elymus sp. — Wild rye grass
  Puccinia clematidis (DC.) Lag. — Rust
    Oregon

Epilobium angustifolium L. — Fireweed
  Pucciniastrum pustulatum (Pers.) Diet. — Rust
    Washington, Oregon. (JSB)

Euphorbia corollata L. — Spurge
  Microsphaera euphorbiae (Pk.) Burk. & Curt. — Powdery mildew
    Ohio (BF)

Euphorbia sp. — Spurge
  Melampsora monticola Mains — Rust
    Oregon (JSB)

Gaultheria shallon Pursh — Aromatic wintergreen
  Mycosphaerella gaultheriae Cke. & Ell. — Leaf spot
    Washington (JSB)
    Oregon - widespread throughout range of host, injury to leaves slight. (JSB)

Gaylussacia baccata (Waug.) C. Koch	Black huckleberry
Meteorological	Freezing
Connecticut - reports and observations include portions of the townships of Plainsfield, Sterling, Canterbury and Brooklyn. Most of the blossoms were killed, only a few berries were found in sheltered places. (JLS)	
Geranium texanum (Trelease) Heller	Geranium
Plasmopora geranii Berl. & De Toni	Downy mildew
Louisiana	
Lapsana communis L.	Nipple-wort
Puccinia lapsanae (Schul.) Fckl.	Rust
Washington (JSB)	
Lathyrus nuttallii S. Wats.	Vetch
Erysiphe polygoni DC.	Powdery mildew
Oregon (JSB)	
Uromyces fabae (Pers.) De Bary	Rust
Oregon (JSB)	
Malva rotundifolia L.	Mallow
Puccinia malvacearum Bertero	Rust
Washington, Oregon. (JSB)	
Malva sp.	Mallow
Puccinia malvacearum Mont.	Rust
California - widespread, can undoubtedly be found anywhere mallow grows. (WSF)	
Madia sp.	Tarweed
Coleosporium madiae Cke.	Rust
Oregon (JSB)	
Mentha sp.	Mint
Puccinia menthae Pers.	Rust
Washington (JSB)	
Menziessia ferruginea Sm.	Fools huckleberry
Rhytisma sp.	Tarspot
Washington - causes little injury to host. (JSB)	
Micromeria chamissonis (Benth.) Greene	Tea vine
Puccinia micromeriae D.T.T.	Rust
Oregon (JSB)	
Oxalis stricta L.	Wood sorrel
Microsphaera russellii Clinton	Powdery mildew
Ohio (BF)	
Physalis longifolia Nutt.	Ground cherry
Mosaic	
Iowa (IEM)	

Physalis spp. — Ground cherry
  Mosaic
    Indiana
  Unknown leaf spot
    West Virginia (RJH)

Pteridium aquilinum pubscens Underw. — Brake
  Uredinopsis mirabilis (Pk.) Magn. — Rust
    Washington, Oregon. (JSB)

Rhus diversiloba Torr. & Gr. — Poison oak
  Cylindrosporium toxicodendri (Curt.) Dearness — Leaf spot
    Oregon

Solanum carolinense L. — Horse nettle
  Mosaic
    Indiana

Thalictrum sp. — Meadow-rue
  Puccinia triticina Eriks. & Henn. — Rust
    Indiana (EBM)

Vaccinum spp. — Huckleberry
  Calyptospora columnaris (Alb. & Schw.) Kühn — Stem blister
    Washington, Oregon. (JSB)
    Widespread throughout range of host and in the above districts. (JSB)
  Exobasidium vaccinii (Fckl.) Wor. — Leaf spot
    Washington (JSB)
  Meteorological — Freezing
    Connecticut - on V. vacillans & V. corymbosum
  Microsphaera alni vaccinii (Schw.) Salm. — Powdery mildew
    Ohio
  Pucciniastrum myrtilli (Schum.) Arth. — Rust
    Oregon (JSB)

Veronica serpyllifolia L. — Thyme leaved speedwell
  Rhizoctonia solani Kühn — Brownpatch
    General - throughout eastern United States. (CVP)

Taraxacum officinale Weber — Dandelion
  Sphaerotheca humuli var. fuligena (Schlecht.) Salm. — Powdery mildew
    Washington - common throughout the Puyallup Valley.

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THE PLANT DISEASE BULLETIN

Issued By

THE PLANT DISEASE SURVEY

Supplement 25

Index to Supplements 20-24

December 15, 1922

BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

INDEX TO SUPPLEMENTS XX - XXIV, PLANT DISEASE BULLETIN

1922

Prepared by Mary G. Van Meter

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X

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Z

ERRATA AND EXPLANATION

Page

32 Read "Bacillus amylovorus" instead of "Bacillus amylovorous".

98 Read "Bacillus amylovorus" instead of "Bacterium amylovorus".

112 Under "Other Diseases", read "Acrostalagmus" instead of "Acrostolagmus".

113 Orange rust, second paragraph, read "blackberries" instead of "raspberries".

128 Read "Avocado" instead of "Avacado".

254, 386, and 505, read "Bacterium solanacearum" instead of "Bacillus solanacearum".

328, 413, and 471, read "Phytophthora terrestris" instead of "Phytophthora terrestria".

419, 420, 421, read "Lophodermium nervisequum" instead of "Lophodermium nervisequium".

425 Read "Merulius americanus" instead of "Meruliose americanus".

446 Read "Botrytis douglasii" instead of "Botrytis douglassi".

452 Read "Bignonia" instead of "Bigonia".

467 Read "Fusarium conglutinans callistephi" instead of "Fusarium conglutinans callestephi".

468 Read "Angular leaf spot caused by Bacteria", instead of "Bacteria sp."

481 Read "Symphoricarpos" instead of "Symphoricarpus".

485 Read "Pteridium aquilinum pubescens" instead of "Pteridium aquilinum pubscens".

[illegible] Read "Vaccinium spp." instead of "Vaccinum spp.".

5[illegible] Read "Phyllosticta solitaria" instead of "Phyllosticta soliteria".